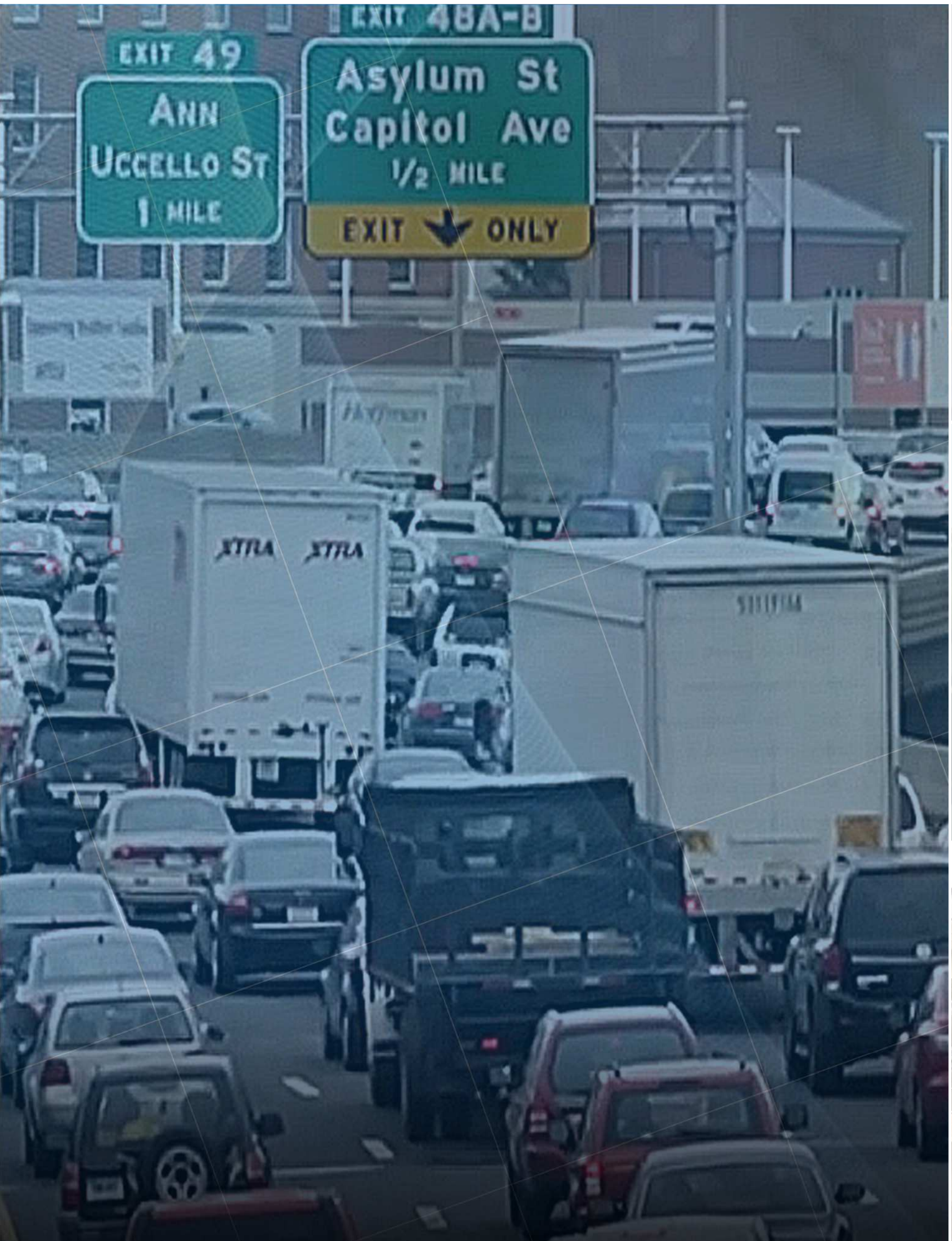
*Executive Summary*

# Connecticut I-84 Corridor Congestion Relief Study

Federal Highway Administration

October 2016





Coordinated and Funded Through the
Federal Highway Administration Value Pricing Pilot Program
and the Connecticut Department of Transportation

CDM Smith

# Executive Summary

# I-84 Corridor Congestion Relief Study

CDM Smith was selected by the Connecticut Department of Transportation (CTDOT) to perform a congestion pricing study of the Interstate 84 Viaduct in Hartford under the Federal Highway Administration (FHWA) Value Pricing Pilot Program (VPPP). This study included the assembly and collection of traffic and travel time data, a stated preference survey to estimate motorists' value of time in the study corridor, and a detailed traffic modeling and toll revenue evaluation for pricing alternatives.

## Study Objective and Scope

The grant application submitted by the CTDOT specifically outlined the I-84 Viaduct through Hartford as a pricing candidate due to its high travel demand, significant congestion, and imminent need of replacement. Congestion pricing may also provide a supplemental funding source, helping to offset the costs that surround such a critical, yet highly expensive replacement. The I-84 Viaduct, built in 1965 is the ¾ mile long section of elevated highway between the Sisson Avenue interchange and the Asylum and Capitol Avenue interchanges.

The use of value pricing in combination with physical and operational improvements to the I-84 corridor through Hartford was evaluated with the purpose of relieving congestion on one of the most heavily travelled and congested corridors in the State. Given the significant cost of replacing the I-84 Viaduct, toll revenue was also a key factor that was considered across alternatives.

To measure and compare potential congestion relief benefits and toll revenue potential across alternatives, performance measures such as traffic, diversion, and revenue were summarized. In addition, a simulation model of the I-84 study area was utilized to quantify and visualize the estimated I-84 congestion relief benefits of the various alternatives and the potential impacts on the local network.

The study also examined converting the existing high occupancy vehicle (HOV) lanes along I-91 and I-84 to high occupancy toll (HOT) lanes where single occupant vehicles would be allowed access to the existing HOV lanes in exchange for paying a toll.

The study was performed in sufficient detail to meet the above objectives and included the following key work efforts:

- Development of a current traffic volume and speed profile for I-84 and I-91, including detailed analysis by time of day and travel direction;
- Conducting a Stated Preference (SP) Survey in the I-84 Hartford travel corridor to estimate motorists value of time;
- Enhancement of the Capitol Region Council of Governments (CRCOG) Travel Demand Model;
- Development of an I-84 micro-simulation traffic model in order to analyze the operational impacts on I-84 and surrounding local roadways under a toll application;

- Estimation of the traffic diversion that can be anticipated from tolling on I-84; and
- Estimation of annual gross toll revenue, tolling capital costs, tolling operating costs, and net toll revenue for final tolling alternatives.

## Study Area

The study area was defined as I-84 from Route 9 in West Hartford to the end of the I-84 HOV lanes in Vernon, and from the I-91 HOV lanes in Windsor to I-691 in Meriden. **Figure ES-1** depicts the regional study area, with major transportation facilities I-91, Route 15, Route 9, and Route 2 running north-south and I-84, I-691 (not shown in figure), I-384, and I-291 running east-west. **Figure ES-2** shows I-84 through the downtown area with the Viaduct section highlighted. Major arterials parallel to I-84 include Farmington and Capitol Avenues.

The rest of this executive summary provides a discussion of the alternatives evaluated, estimates of traffic and toll revenue, and roadway operational impacts that should be considered in any potential tolling of a new I-84 Viaduct replacement through Hartford.

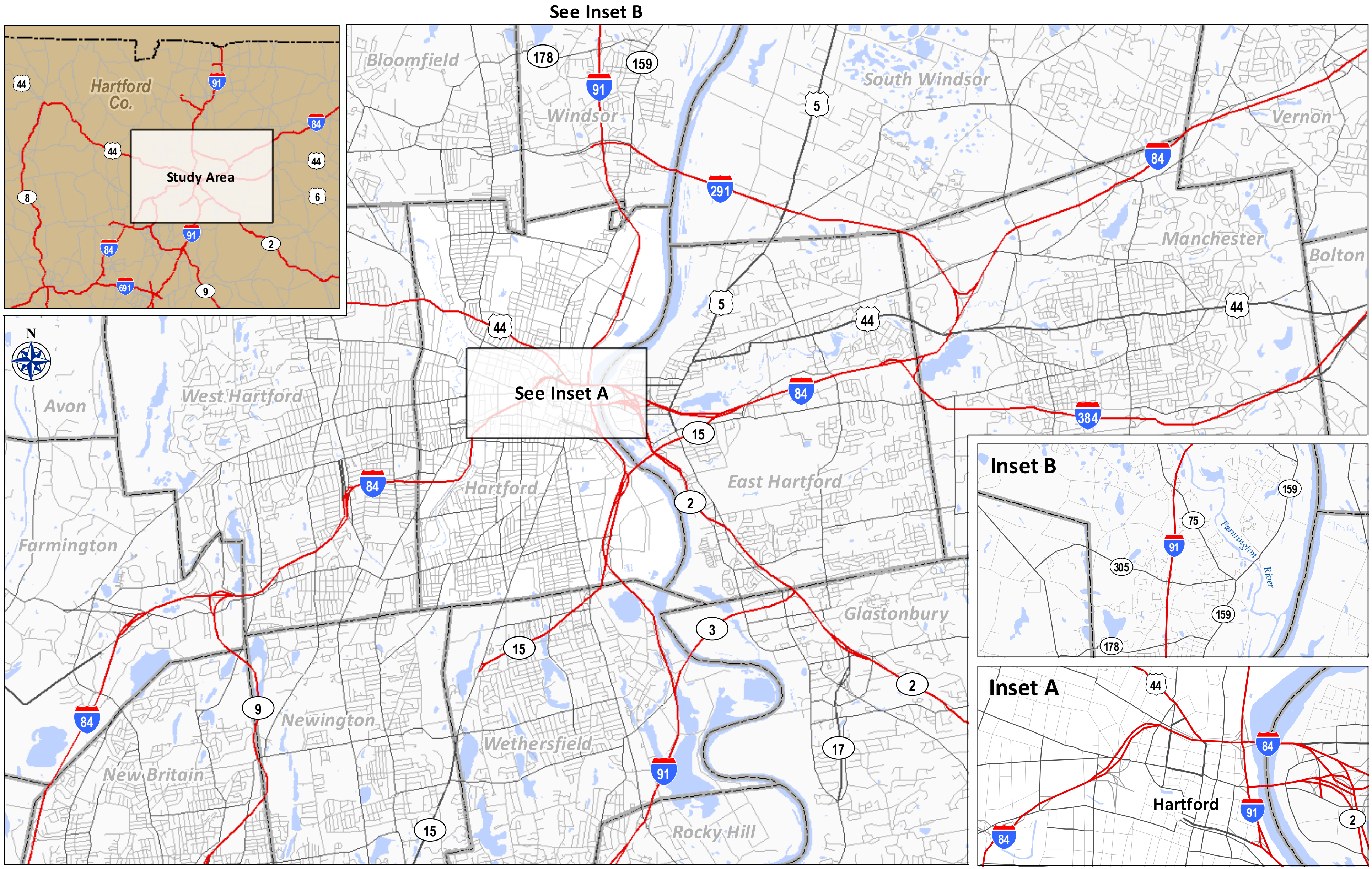
## Alternatives Description

The alternatives considered in this study assumed all electronic tolling (AET) across all lanes on I-84 within the Hartford Area. As this study developed, an additional scenario beyond the physical limits of the I-84 Viaduct in Hartford was evaluated that considered expanded tolling along I-84 between Hartford and Danbury. In addition, a potential conversion of the existing High Occupancy Vehicle (HOV) lanes on I-84 and I-91 to High Occupancy Toll (HOT) lanes was studied to estimate the potential toll revenue and congestion relief benefits that could occur under such a conversion.

Parallel to this congestion pricing study, a major investment study of I-84 in Hartford was initiated by the CTDOT to develop a set of preliminary alternatives for replacing the existing I-84 viaduct. During this congestion relief study, two preliminary physical alternatives were developed by the I-84 Hartford Project team for use in the technical evaluation of tolling.

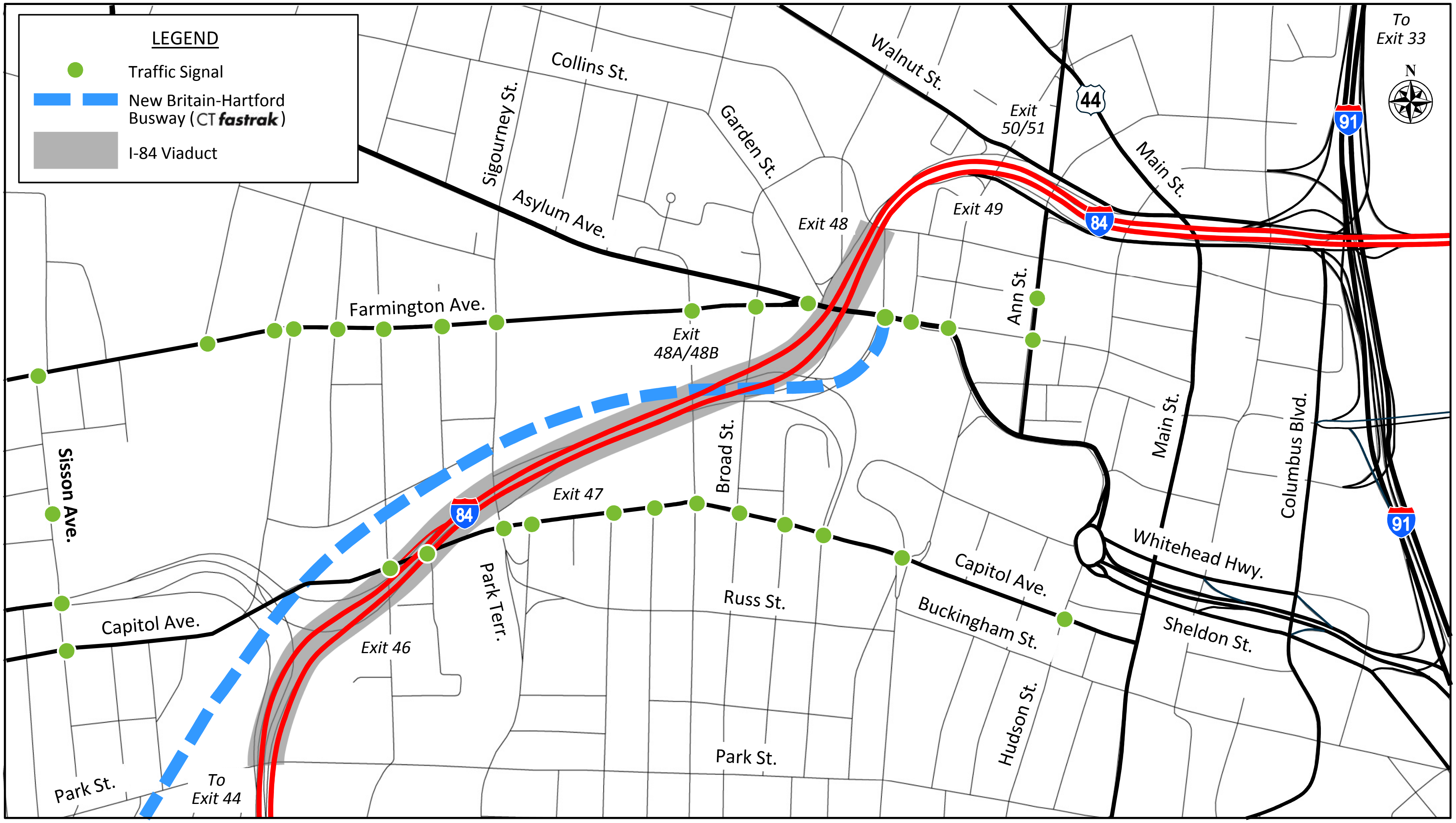
The alternatives evaluated in this study are discussed below.

- **Alternative 1-** Assumes the current configuration ("No Build") of I-84 with a single point toll gantry located east of the Sigourney ramps **(Figure ES-3)**. The toll for a passenger vehicle equipped with a transponder was assumed to be $1.00 and $0.75 for peak and off peak time periods, respectively.
- **Alternative 2 -** Assumes the current configuration ("No Build") of I-84 with two tolling locations. The first gantry was assumed to be west of the Sisson Avenue Interchange and the second gantry east of the Asylum/Capitol Avenue interchange **(Figure ES-3)**. The toll at each location for a passenger vehicle equipped with a transponder was assumed to be $0.50 and $0.375 for peak and off peak time periods, respectively.
- **Alternative 3 –** Assumes a reconfigured I-84 through Hartford with major reconstruction and consolidation of the existing interchanges on the western and eastern edges of the Viaduct. The interchange with Sigourney Street is removed **(Figure ES-4)**. Alternative 3 assumes the same point toll location as used in Alternative 1. The toll for a passenger vehicle equipped with a




# REGIONAL STUDY AREA

FIGURE ES-1

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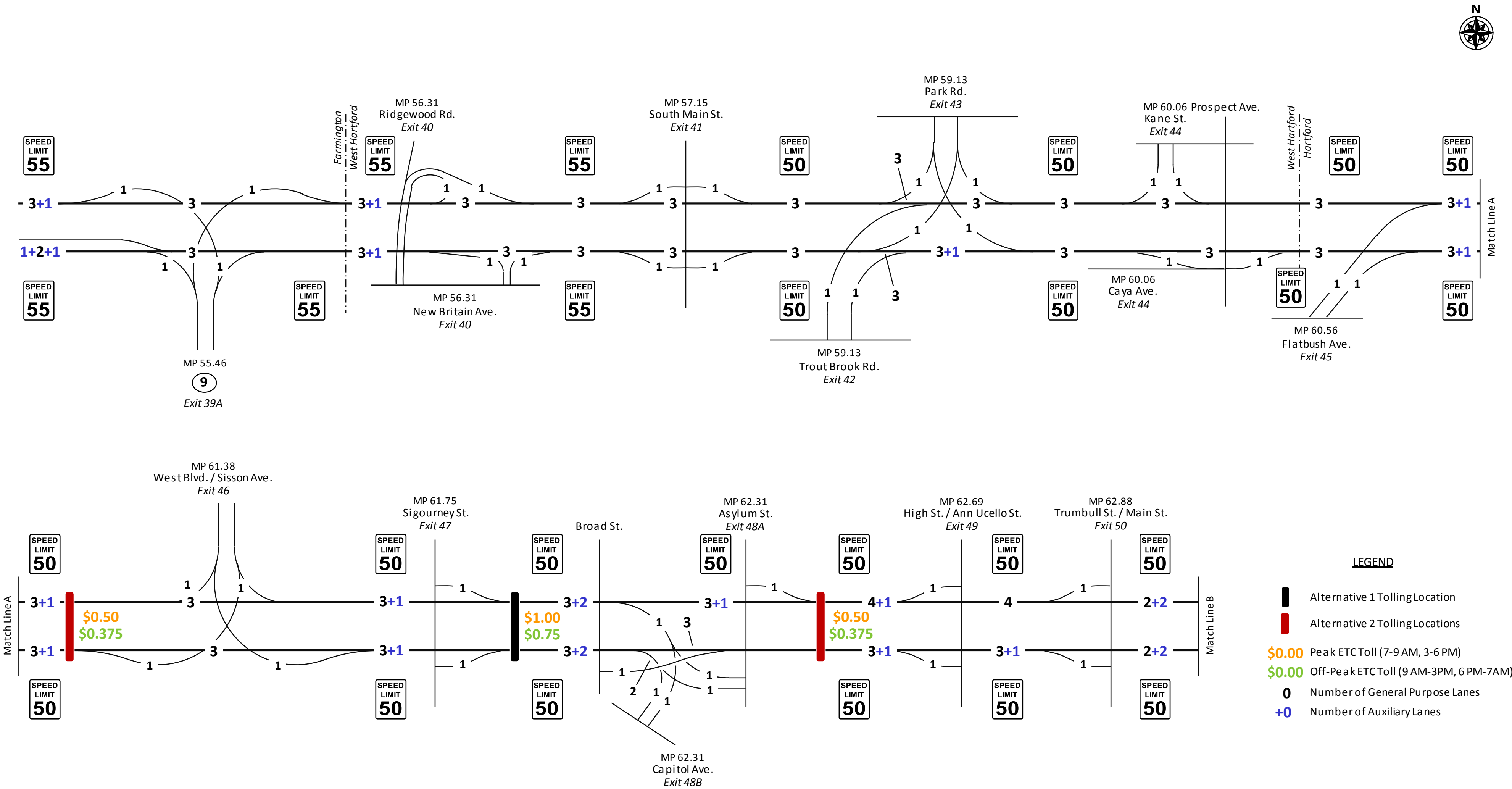
# I-84 VIADUCT LOCATION MAP

FIGURE ES-2




# ALTERNATIVES 1 AND 2 - I-84 NUMBER OF LANES, POSTED SPEED LIMITS AND ASSUMED TOLLING LOCATIONS

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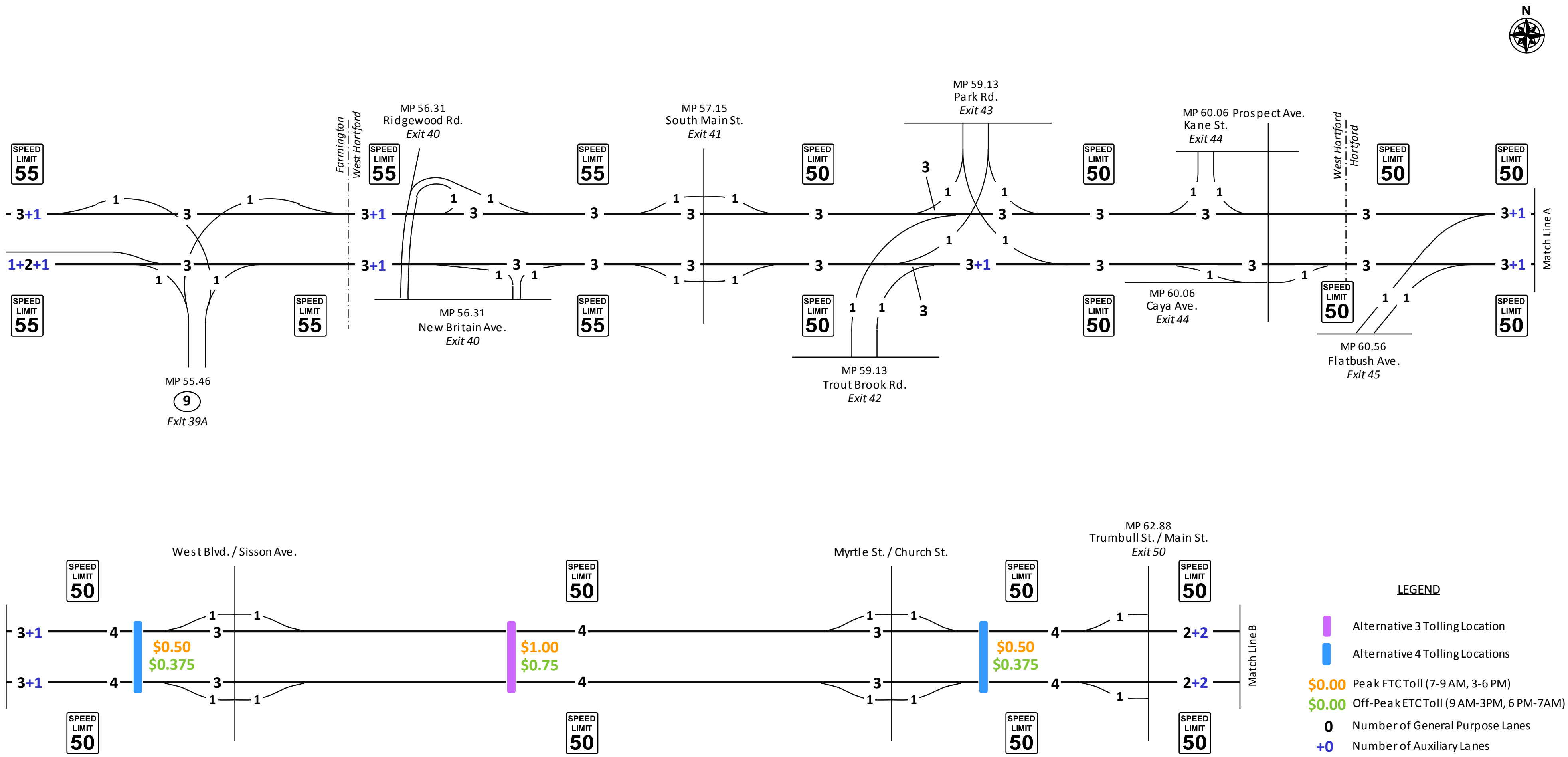
FIGURE ES-3




# ALTERNATIVES 3 AND 4 - I-84 NUMBER OF LANES, POSTED SPEED LIMITS AND ASSUMED TOLLING LOCATIONS

FIGURE ES-4

transponder was assumed to be $1.00 and $0.75 for peak and off peak time periods, respectively.

- **Alternative 4** – Same as Alternative 3, but with two tolling locations. The first tolling gantry is assumed to be west of a new West Boulevard/Sisson Avenue Interchange and the second tolling location east of a new Church Street interchange. The toll at each location for a passenger vehicle equipped with a transponder was assumed to be $0.50 and $0.375 for peak and off peak time periods, respectively **(Figure ES-4)**.
- **Alternative 5 -** Assumes I-84 is reconfigured through Hartford with the addition of a collector-distributor (C-D) roadway **(Figure ES-5)**. This alternative assumes two tolling locations, strategically positioned just outside of the C-D and I-84 connections so as to prevent the C-D roadway from being used as a toll diversion alternative. The toll at each location for a passenger vehicle equipped with a transponder was assumed to be $0.50 and $0.375 for peak and off peak time periods, respectively.
- **Alternative 6 -** Assumes an expanded tolling configuration consisting of 11 AET locations spaced approximately 6 miles apart along I-84 from the New York border to Hartford **(Figure ES-6)**. The toll at each location for a passenger vehicle equipped with a transponder was assumed to be $0.50 and $0.35 for peak and off peak time periods, respectively.
- **Alternative 7 -** Assumes the conversion of the existing I-91 and I-84 HOV lanes to HOT lanes. Toll rates would vary dynamically in response to traffic conditions to ensure the HOT lanes operate near or at free flow at all times of the day. **Figures ES-7 through ES-10** show the current configuration of the HOV lanes and the access and egress locations between the general purpose lanes and the HOV lanes. The existing physical configuration of the HOV lanes is such that a single tolling location could be implemented on each of the corridors to manage single occupant demand through pricing.

These seven alternatives were run utilizing travel demand toll models specifically enhanced and refined for this study at 2012, 2020 and 2040 conditions. In addition, toll free runs were prepared to serve as the baseline to compare against the tolled alternatives

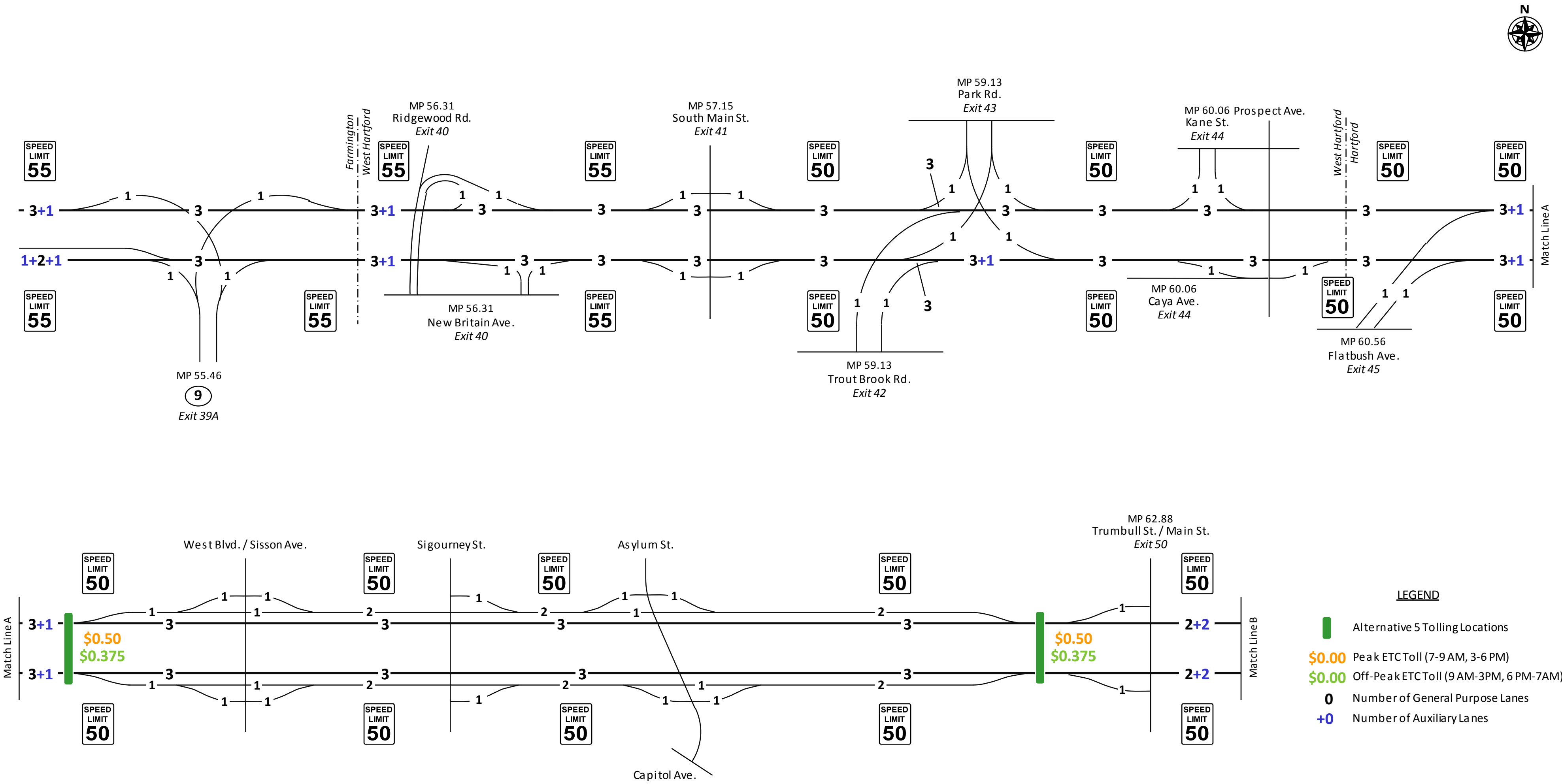
## Summary of Traffic Estimates

Model runs were reviewed and summarized into volume line charts for ease of comparison and to demonstrate the estimated volume profile along I-84 between the Route 9 and I-384 interchanges for the different tolling scenarios.

### Toll Free versus Alternative 1 and Alternative 2

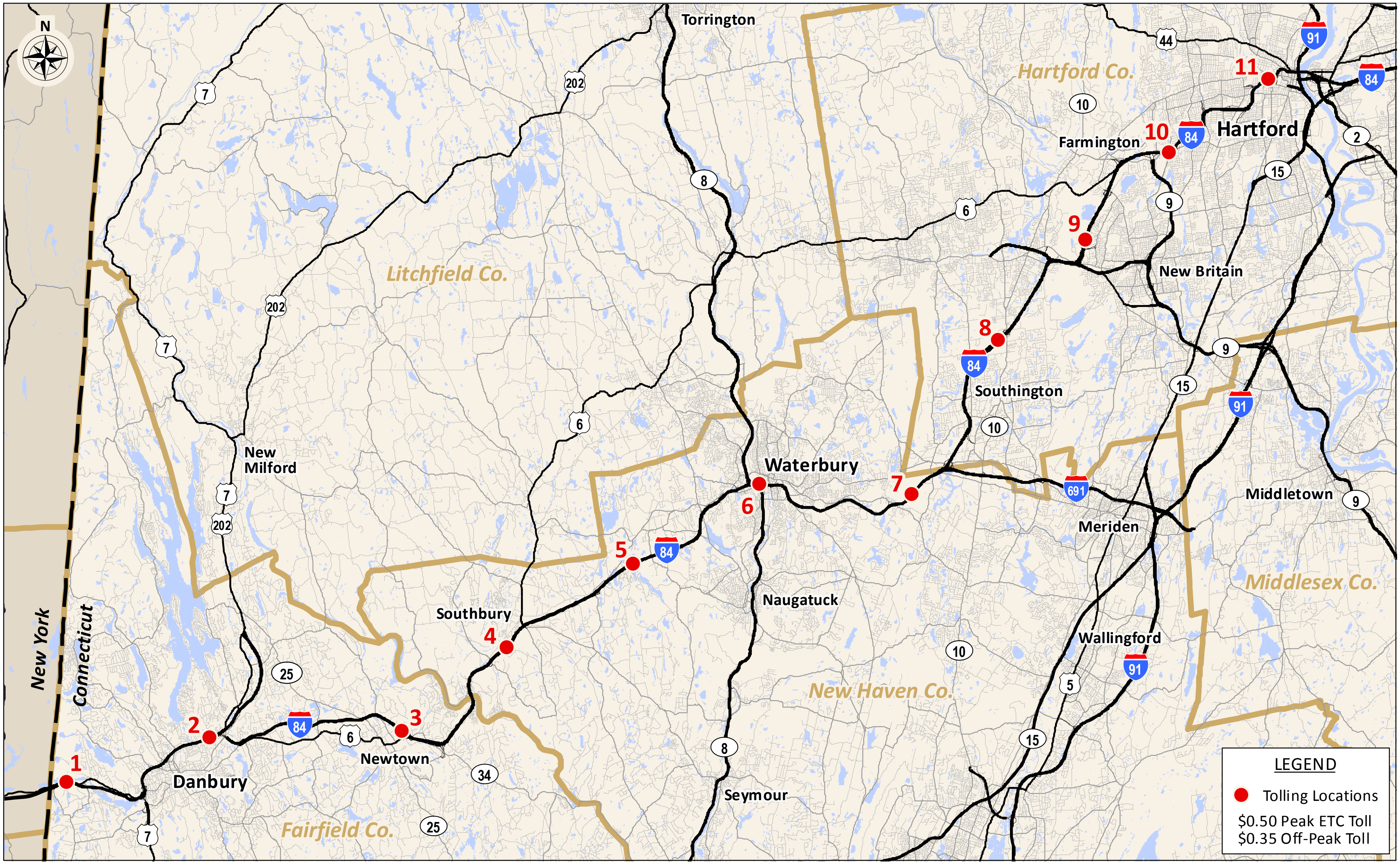
**Figures ES-11** shows the 2020 estimated average weekday traffic by travel direction during the AM (7-9AM) and PM (3-6PM) peak periods for the existing toll free configuration, Alternative 1 (single point toll), and Alternative 2 (two tolling locations). Since all three of these scenarios use the existing configuration, the differences displayed here are a direct result of the toll rate and tolling location(s).

**Figure ES-12** shows the same information, but for the midday period and for the average weekday total. The total day chart on the lower half of the figure clearly demonstrates the impact of the single point toll (Alternative 1) and the impact of locating two tolling locations (Alternative 2) in the viaduct area of I-84. At the west end of the limits shown, we can conclude that about 5 percent of the reduction in traffic can likely be attributed to a regional diversion to avoid the toll. At the east end of



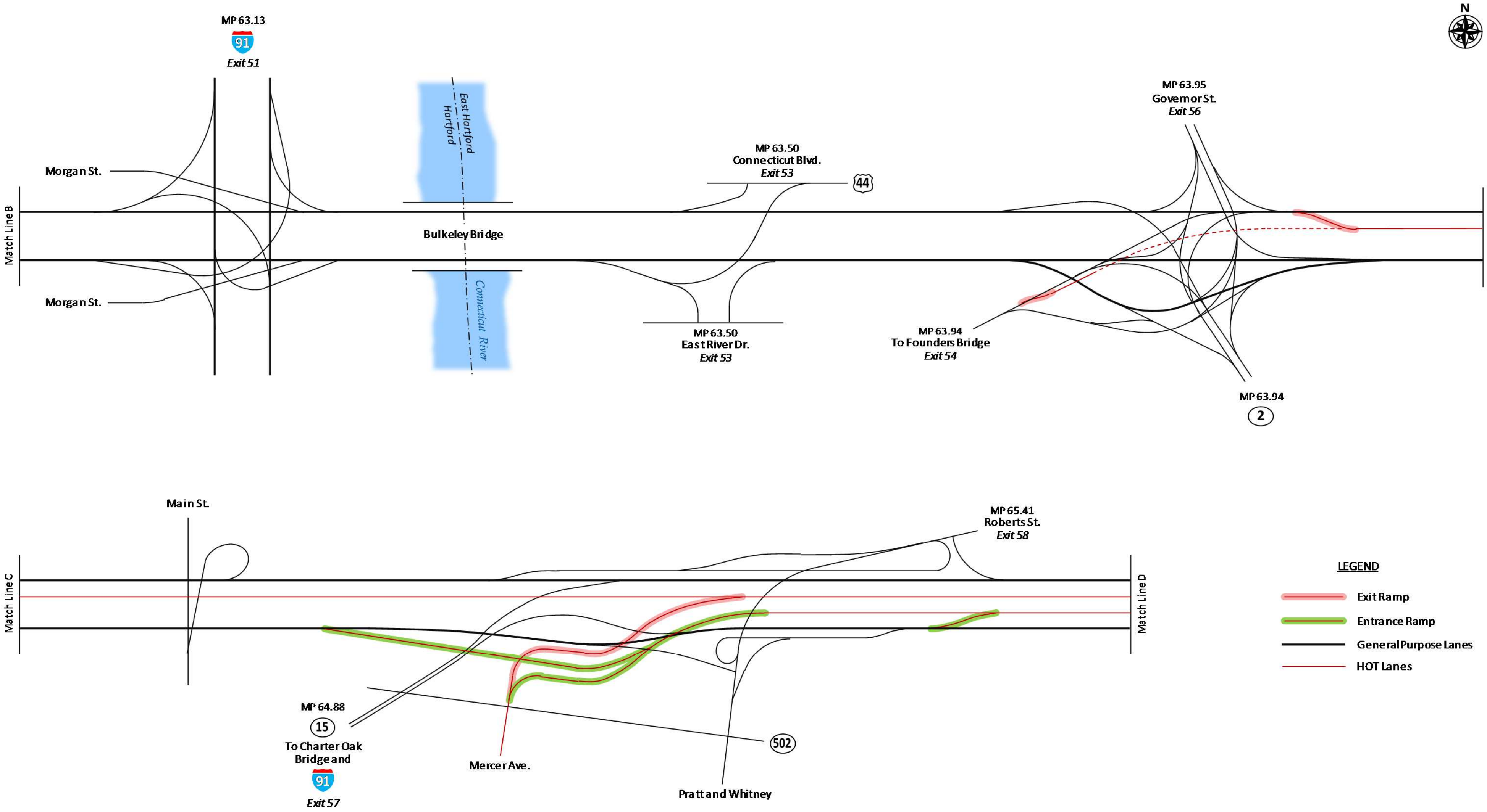

# ALTERNATIVE 5 - I-84 NUMBER OF LANES, POSTED SPEED LIMITS AND ASSUMED TOLLING LOCATIONS

FIGURE ES-5



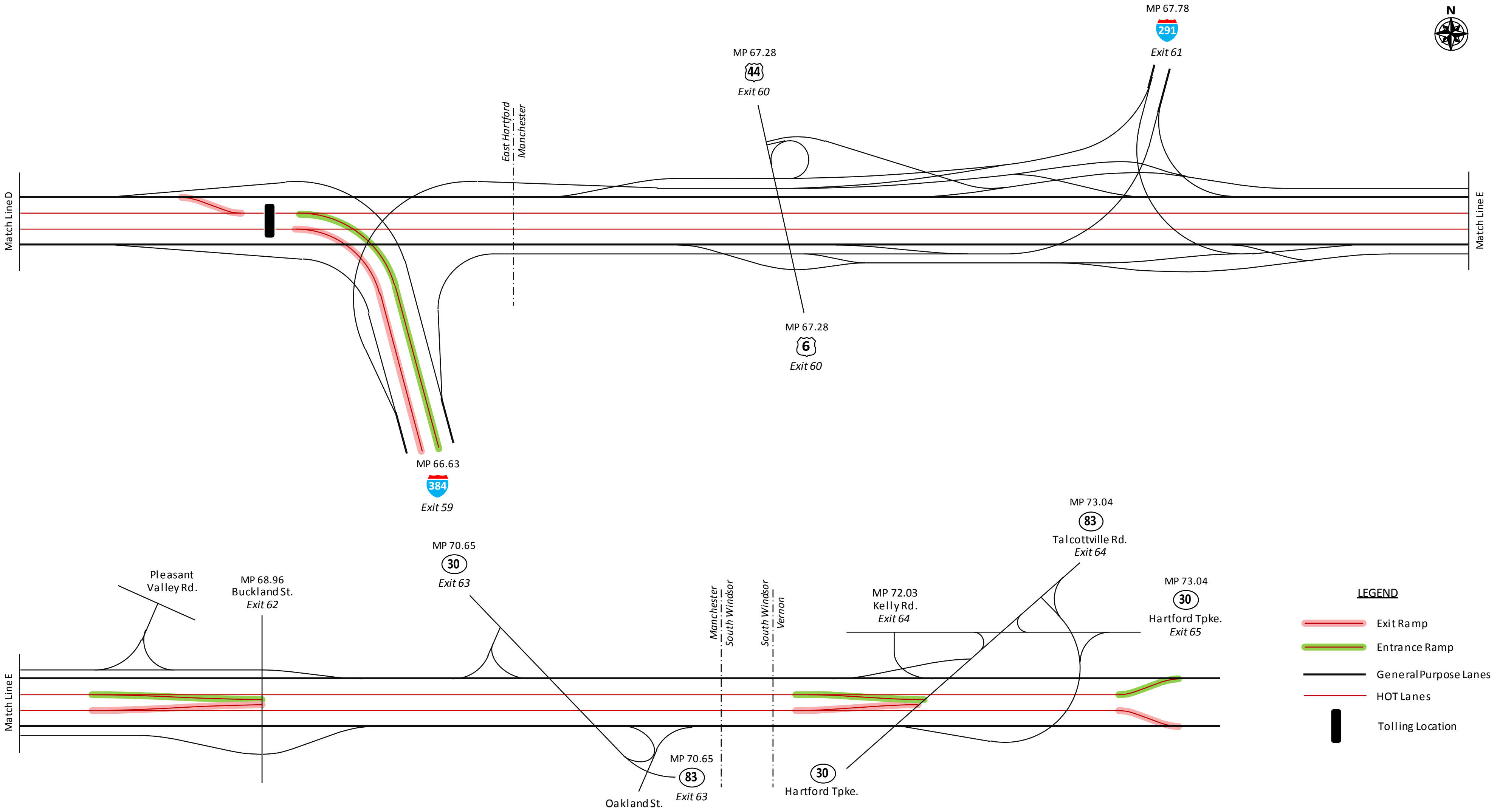

# ALTERNATIVE 6 - EXPANDED I-84 TOLLING (NY-HARTFORD): GANTRY LOCATIONS

FIGURE ES-6



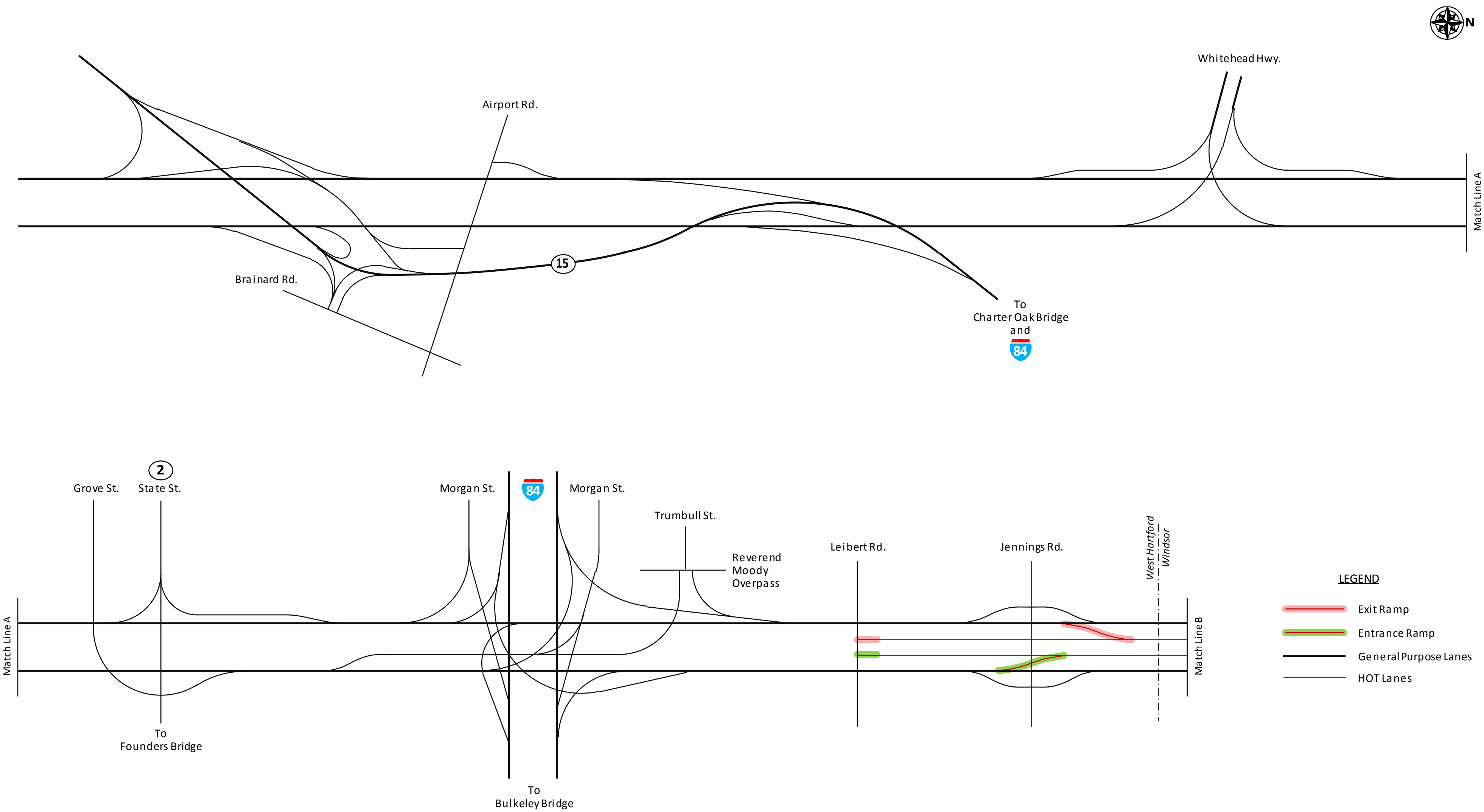

# ALTERNATIVE 7 - I-84 HOV TO HOT CONVERSION

FIGURE ES-7



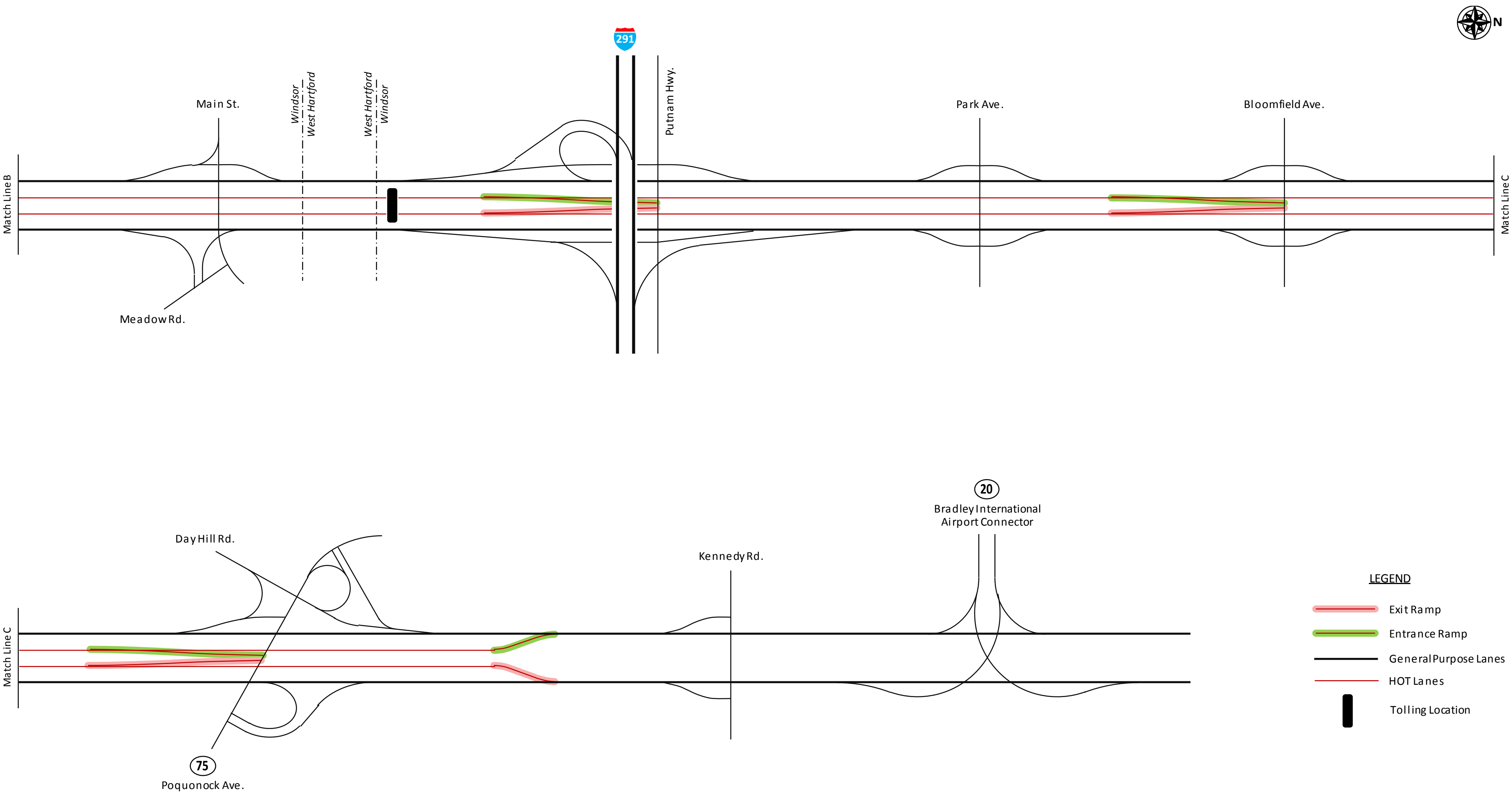

# ALTERNATIVE 7 - I-84 HOV TO HOT CONVERSION

FIGURE ES-8




# ALTERNATIVE 7 - I-91 HOV TO HOT CONVERSION

FIGURE ES-9

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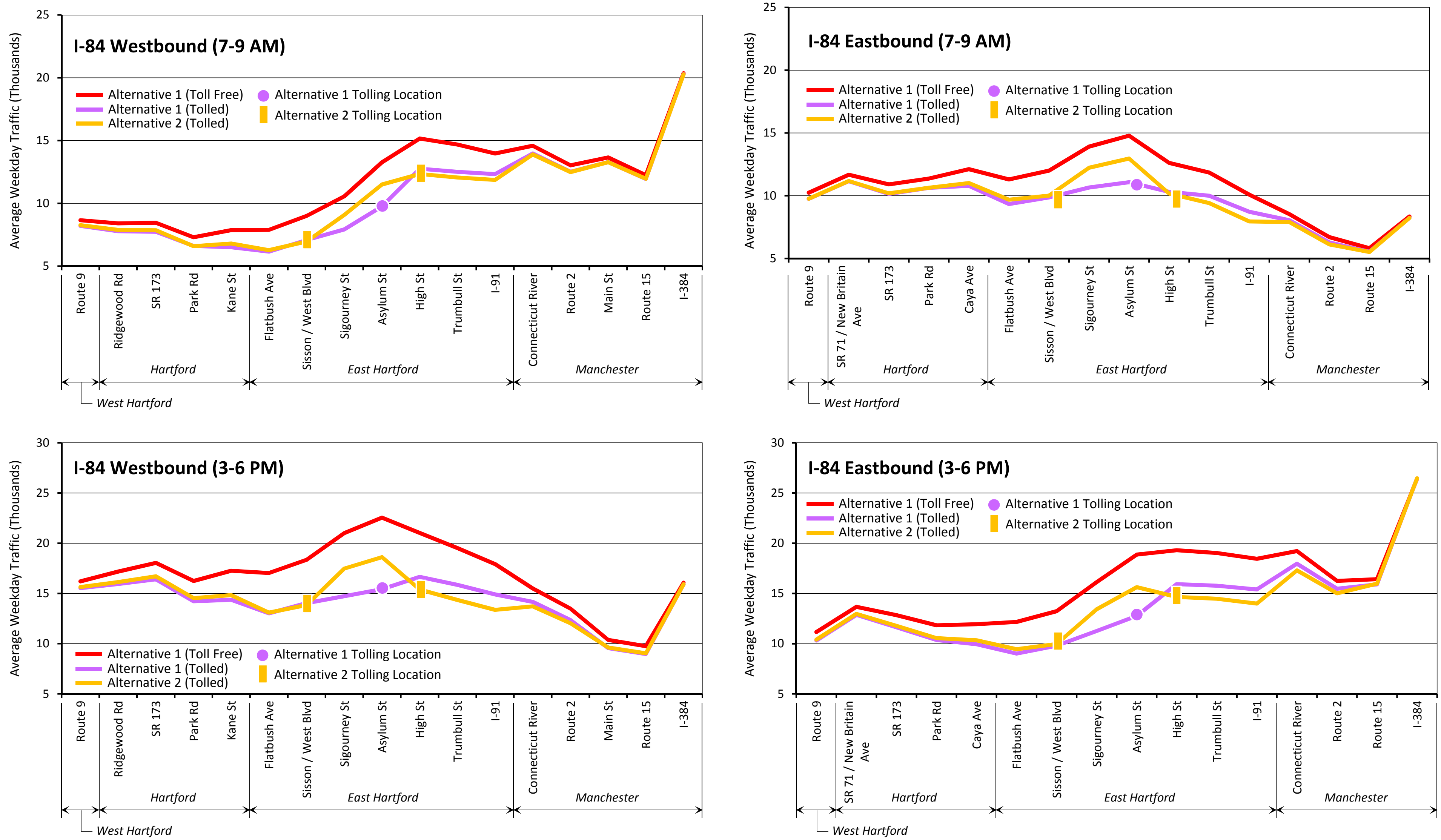
# ALTERNATIVE 7 - I-91 HOV TO HOT CONVERSION

FIGURE ES-10




# 2020 ESTIMATED AVERAGE DAILY TRAFFIC
# ALTERNATIVE 1 (TOLL FREE), ALTERNATIVE 1 (TOLLED), ALTERNATIVE 2 (TOLLED)
# AM (7-9 AM) AND PM (3-6 PM) PERIODS

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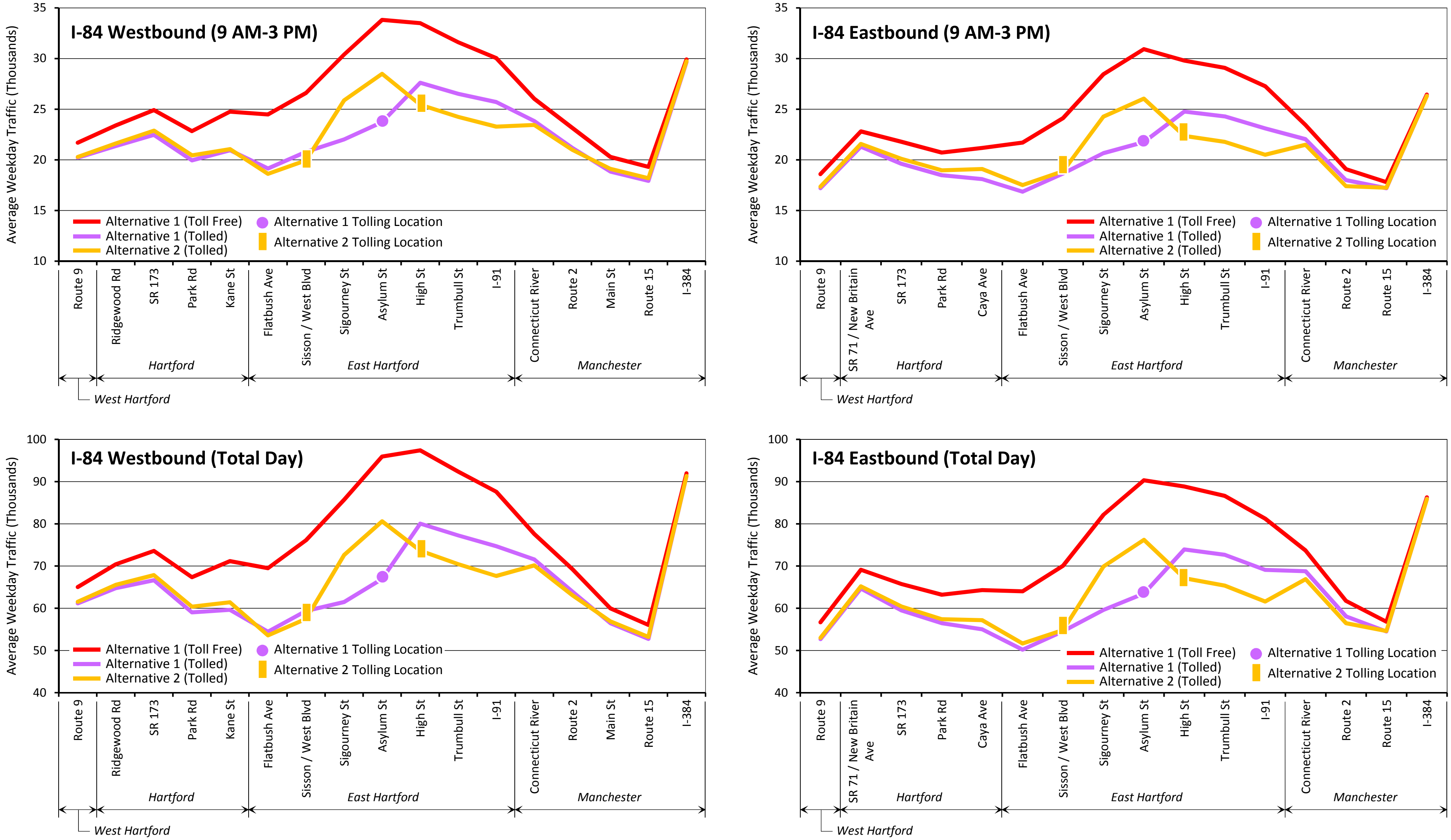
FIGURE ES-11




# 2020 ESTIMATED AVERAGE DAILY TRAFFIC
# ALTERNATIVE 1 (TOLL FREE), ALTERNATIVE 1 (TOLLED), ALTERNATIVE 2 (TOLLED)
# MIDDAY (9 AM-3 PM) AND TOTAL DAY PERIODS

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FIGURE ES-12

the limits, traffic is similar among all three alternatives. Clearly, the diversion is concentrated locally, with traffic exiting I-84 at an earlier interchange, entering I-84 at a later interchange, or using a local highway or arterial to enter/exit Hartford to avoid the toll.

As would be expected under Alternative 1, the largest reduction in traffic occurs at the tolling location, where a 30 percent reduction in average weekday traffic could be expected. The percentage of retained traffic increases the further away from the tolling location, with only a 5 percent reduction in traffic estimated west of the Route 9 interchange. The roadway network and the frequency of interchanges in Hartford allow for traffic to exit I-84 prior to the tolling location or enter I-84 beyond the tolling location. Because a significant amount of the traffic on I-84 in Hartford has origins or destinations in the local area, coupled with relatively dense network, a significant amount of toll avoidance would be possible (even at the relatively modest toll rate assumed).

Alternative 2, assumes two tolling locations; one located just west of the Sisson Avenue interchange and the second location located east of the Asylum Street interchange. As expected, traffic reductions are highest at the two tolling locations, where a roughly 24 percent reduction in traffic is estimated under a tolled condition. Through the Viaduct section (just west and east of the Sigourney interchange), traffic is estimated to be about 85 percent of toll free volumes. Overall, percent retained levels tend to be higher under Alternative 2 when compared to Alternative 1. The exception being on the eastern end of I-84 (west of the CT River), where the high volume of traffic to and from the east at the Asylum/Broad Street interchanges is now subject to a toll, whereas under Alternative 1, this movement is not tolled.

### Toll Free versus Alternative 3 and Alternative 4

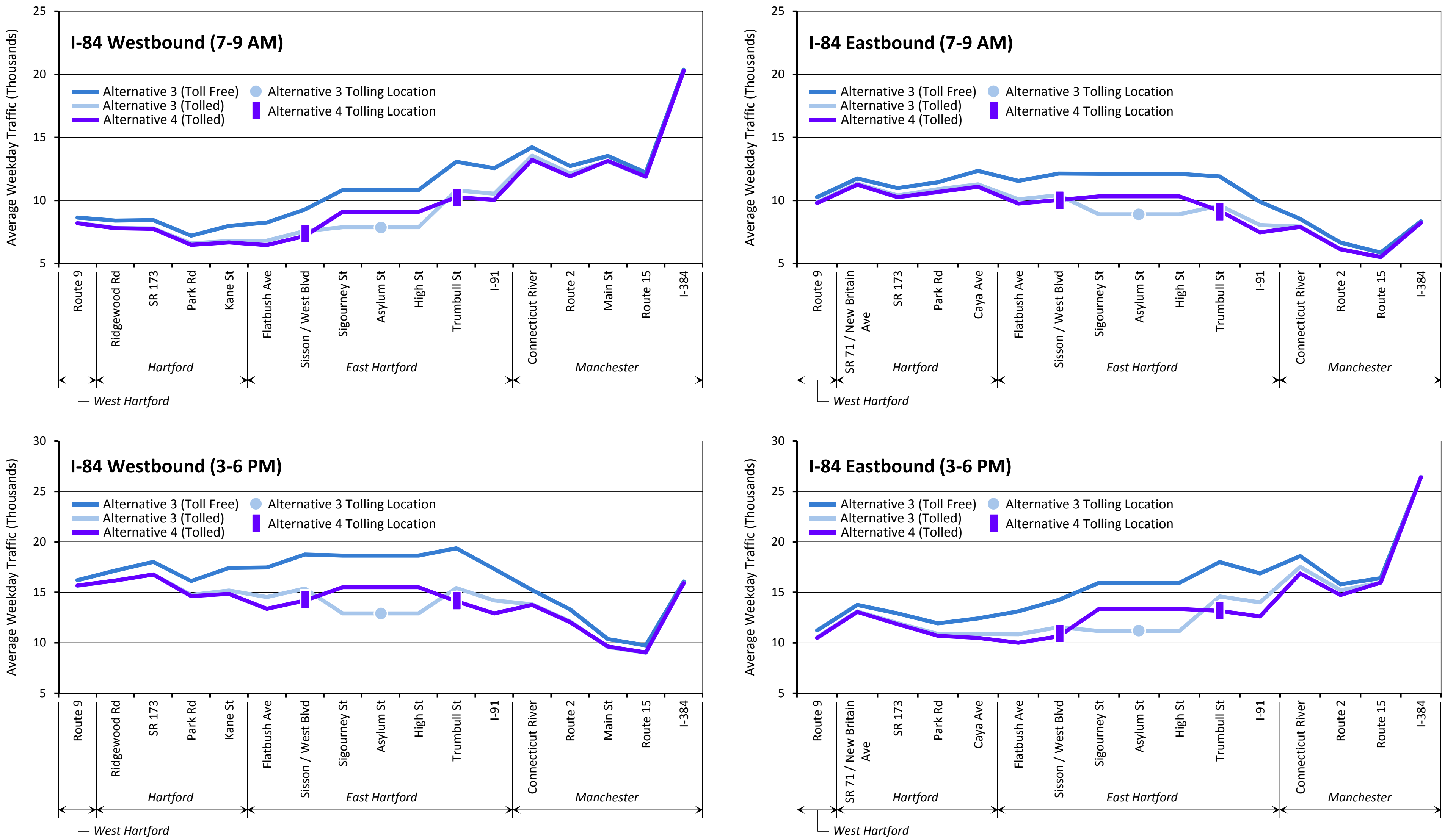
**Figures ES-13** shows the 2020 estimated average weekday traffic by travel direction during the AM (7-9AM) and PM (3-6PM) peak periods for toll free conditions under this build configuration, Alternative 3 (point toll), and Alternative 4 (two tolling locations). All three of these volume profiles reflect the physical changes of a major reconstruction of I-84 in Hartford and the consolidation of interchanges into two major interchanges. Demand through the Viaduct section of I-84 under this build configuration is estimated to be lower than the no build (current) configuration. Under tolling, traffic under these alternatives have similar reactions to those found in Alternative 1 and 2. **Figure ES-14** shows the same information, but for the Midday period and for the average weekday total.

### Toll Free versus Alternative 5

**Figures ES-15** shows the 2020 estimated average weekday traffic by travel direction during the AM (7-9AM) and PM (3-6PM) peak periods for toll free conditions under this build configuration and Alternative 5 (two tolling locations). **Figure ES-16** shows the same information, but for the Midday period and for the average weekday total. Under tolling, traffic is estimated to behave similar to Alternative 2 and 4. Volumes through the Viaduct section, including the sum of volumes on both the I-84 mainline and the C-D road fall in between those estimated for Alterative 2 and Alternative 4, which is attributed to the physical difference among the alternatives.

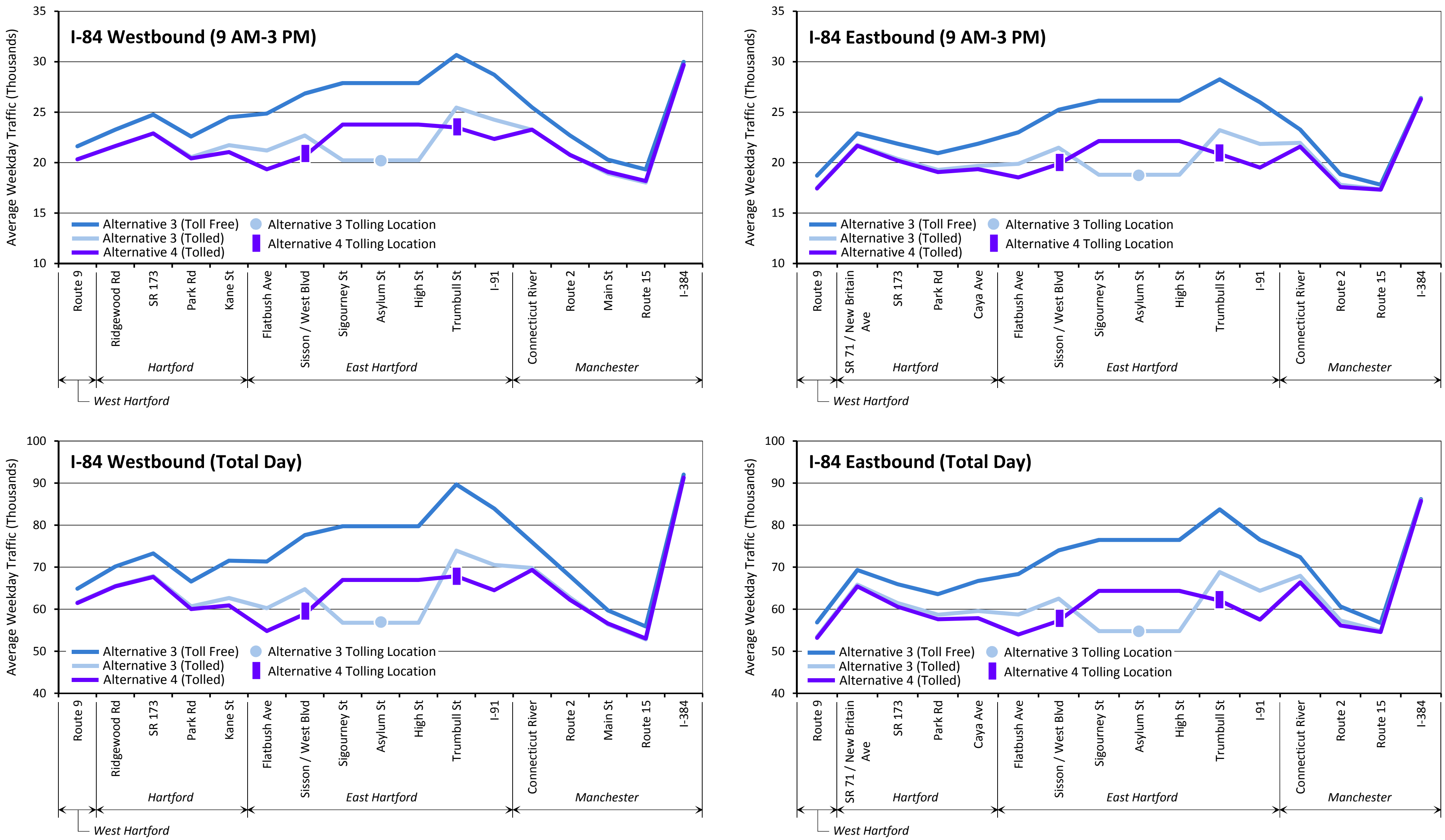
### Alternative 6 - I-84 Expanded Tolling

**Figures ES-17** displays 2020 and 2040 estimated volumes in thousands for a scenario that considers tolling I-84 between Hartford and NY along I-84. Both tolled and toll free traffic estimates are shown at each of the assumed 11 tolling locations for 2020 and 2040. Passenger vehicles equipped with a transponder would be charged $0.50 at each location during the peak periods and $0.35 during off peak periods. Passenger vehicles not equipped with a transponder would be assessed a toll that is 50



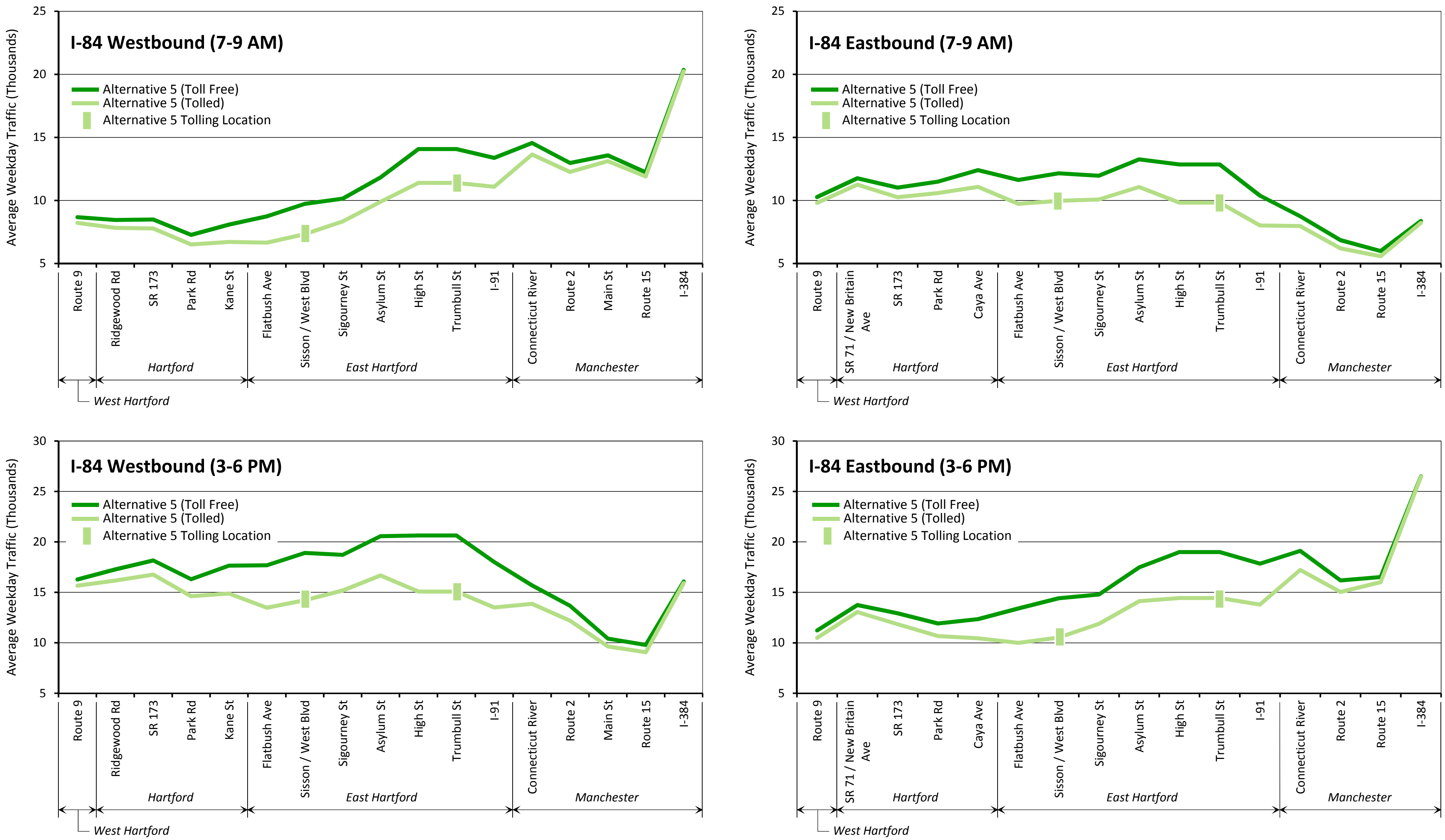

# 2020 ESTIMATED AVERAGE DAILY TRAFFIC
# ALTERNATIVE 3 (TOLL FREE), ALTERNATIVE 3 (TOLLED), ALTERNATIVE 4 (TOLLED)
# AM (7-9 AM) AND PM (3-6 PM) PERIODS

FIGURE ES-13



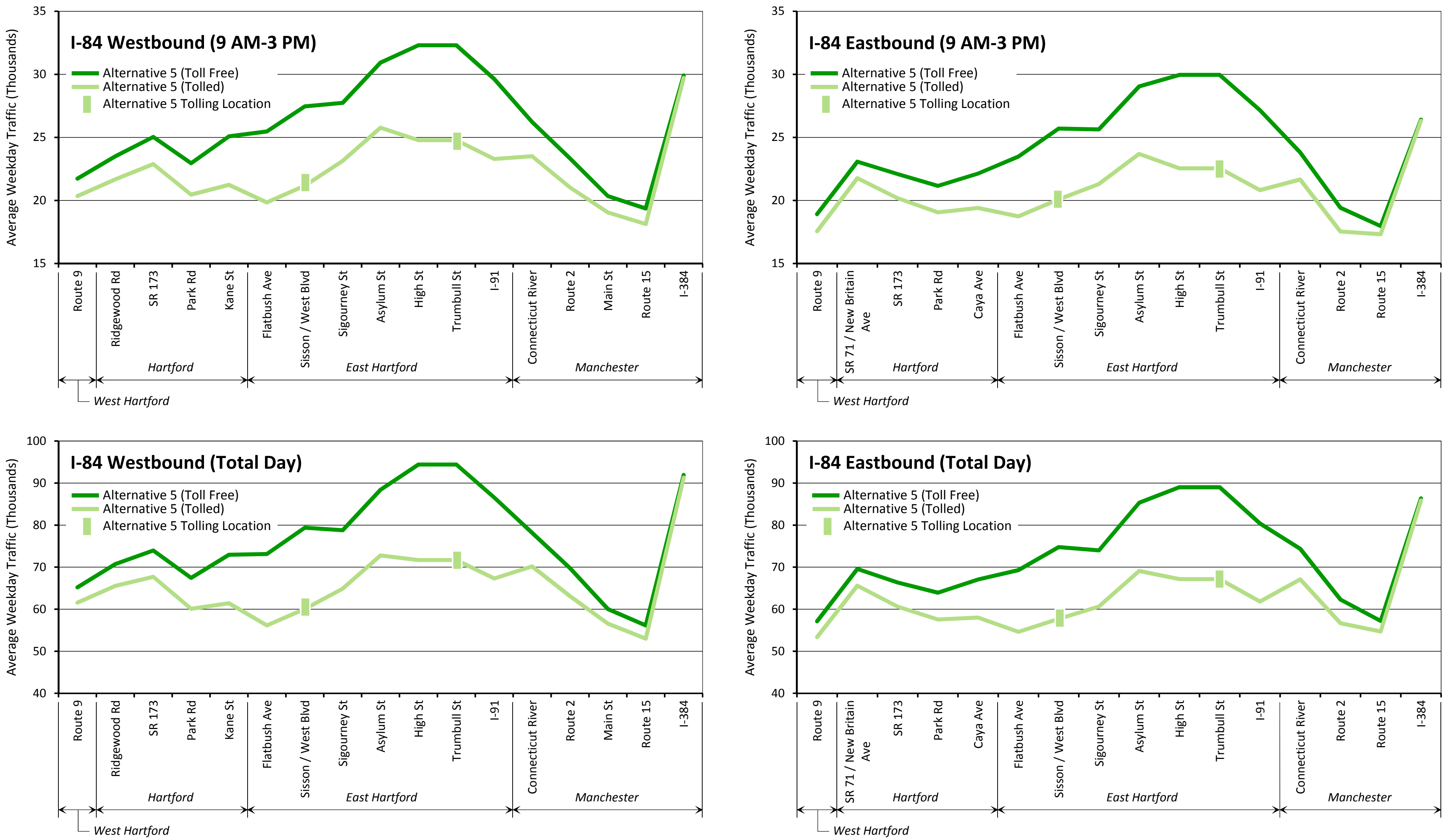

# 2020 ESTIMATED AVERAGE DAILY TRAFFIC ALTERNATIVE 3 (TOLL FREE), ALTERNATIVE 3 (TOLLED), ALTERNATIVE 4 (TOLLED) MIDDAY (9 AM-3 PM) AND TOTAL DAY PERIODS

FIGURE ES-14




# 2020 ESTIMATED AVERAGE DAILY TRAFFIC ALTERNATIVE 5 (TOLL FREE), ALTERNATIVE 5 (TOLLED) AM (7-9 AM) AND PM (3-6 PM) PERIODS

FIGURE ES-15




# 2020 ESTIMATED AVERAGE DAILY TRAFFIC ALTERNATIVE 5 (TOLL FREE), ALTERNATIVE 5 (TOLLED) MIDDAY (9 AM-3 PM) AND TOTAL DAY PERIODS

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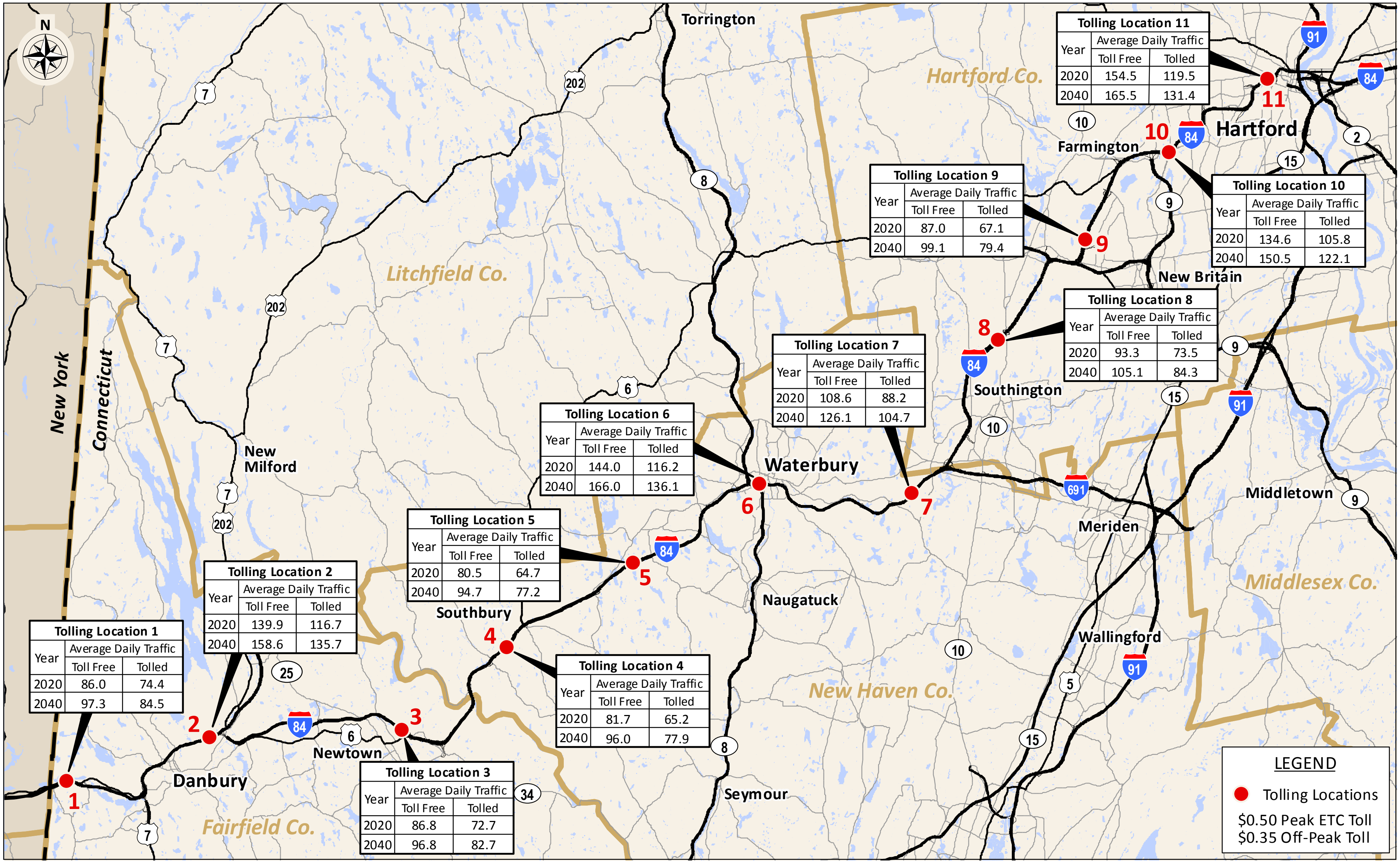
FIGURE ES-16




**Tolling Location 1**

| Year | Average Daily Traffic: Toll Free | Average Daily Traffic: Tolled |
|---|---|---|
| 2020 | 86.0 | 74.4 |
| 2040 | 97.3 | 84.5 |

**Tolling Location 2**

| Year | Average Daily Traffic: Toll Free | Average Daily Traffic: Tolled |
|---|---|---|
| 2020 | 139.9 | 116.7 |
| 2040 | 158.6 | 135.7 |

**Tolling Location 3**

| Year | Average Daily Traffic: Toll Free | Average Daily Traffic: Tolled |
|---|---|---|
| 2020 | 86.8 | 72.7 |
| 2040 | 96.8 | 82.7 |

**Tolling Location 4**

| Year | Average Daily Traffic: Toll Free | Average Daily Traffic: Tolled |
|---|---|---|
| 2020 | 81.7 | 65.2 |
| 2040 | 96.0 | 77.9 |

**Tolling Location 5**

| Year | Average Daily Traffic: Toll Free | Average Daily Traffic: Tolled |
|---|---|---|
| 2020 | 80.5 | 64.7 |
| 2040 | 94.7 | 77.2 |

**Tolling Location 6**

| Year | Average Daily Traffic: Toll Free | Average Daily Traffic: Tolled |
|---|---|---|
| 2020 | 144.0 | 116.2 |
| 2040 | 166.0 | 136.1 |

**Tolling Location 7**

| Year | Average Daily Traffic: Toll Free | Average Daily Traffic: Tolled |
|---|---|---|
| 2020 | 108.6 | 88.2 |
| 2040 | 126.1 | 104.7 |

**Tolling Location 8**

| Year | Average Daily Traffic: Toll Free | Average Daily Traffic: Tolled |
|---|---|---|
| 2020 | 93.3 | 73.5 |
| 2040 | 105.1 | 84.3 |

**Tolling Location 9**

| Year | Average Daily Traffic: Toll Free | Average Daily Traffic: Tolled |
|---|---|---|
| 2020 | 87.0 | 67.1 |
| 2040 | 99.1 | 79.4 |

**Tolling Location 10**

| Year | Average Daily Traffic: Toll Free | Average Daily Traffic: Tolled |
|---|---|---|
| 2020 | 134.6 | 105.8 |
| 2040 | 150.5 | 122.1 |

**Tolling Location 11**

| Year | Average Daily Traffic: Toll Free | Average Daily Traffic: Tolled |
|---|---|---|
| 2020 | 154.5 | 119.5 |
| 2040 | 165.5 | 131.4 |

# ALTERNATIVE 6 - EXPANDED I-84 TOLLING (NY-HARTFORD): GANTRY LOCATIONS

FIGURE ES-17

percent higher than the transponder toll rate. Trucks would be charged a proportionately higher toll rate depending on the number of axles.

In general, it is estimated that approximately 82 percent of the toll free traffic on average would be retained at the tolling locations. Some toll locations would tend to have higher diversion while others would have lower diversion depending on the relative attractiveness and ease of using an alternate route, travel patterns, and traffic composition. Actual tolling locations and toll rates would be further refined if such a tolling alternative was to move forward.

### Alternative 7 – I-91 and I-84 High Occupancy Toll (HOT) Lanes

**Figure ES-18** displays the 2020 estimated AM peak period volumes in thousands for the I-91 HOT lanes Alternative in the southbound and northbound directions. The southbound direction is the heaviest travel direction during the AM Peak Period. It should be noted that the toll system of the HOT lanes would be set dynamically to manage the amount of single occupant vehicles (SOVs) entering the HOT lanes at any time, thereby ensuring that the HOT lanes provide a reliable and time savings alternative to the general purpose lanes. Typically, the total traffic that is allowed on a HOT lane to ensure a reliable travel speed is around 1,500 vehicles per lane per hour. In addition, the tolling policy utilized for this analysis assumed a traffic maximization rather than a revenue optimization approach, meaning that the lowest toll rate was selected that limited volume to 1,500 vehicles per lane per hour.

During both the 7-8AM and 8-9AM peak hours in the southbound direction, there are about 700 high occupancy vehicles (HOVs) in the HOT lane, and another 700 to 800 SOVs that are estimated to be willing to pay a toll to utilize the time savings and reliability benefit of the HOT lane. The northbound direction is the off peak direction during the AM and thus far fewer vehicles are estimated to use the HOT lane.

**Figure ES-19** displays the same information for the I-91 HOT lanes, but for the PM peak period hours. During the PM peak period, congestion is present in both the southbound and northbound directions on I-91. Between the hours of 4 and 6PM in each travel direction, between 1,100 and 1,500 single occupant vehicles and about 1,200 to 1,300 high occupancy vehicles are estimated to use the HOT lane, respectively.

**Figures ES-20** displays the 2020 estimated AM peak period volumes in thousands for the I-84 HOT lanes. During the AM peak period, the major travel direction is westbound as large amounts of traffic are heading to Hartford employment centers. During the 7 to 8AM peak hour, an estimated 800 SOVs would choose to use the HOT lanes over the general purpose lanes. This is in addition to the 700 HOVs.

**Figure ES-21** displays the same information for the I-84 HOT lanes, but for the PM peak period. The eastbound direction is the peak travel direction. An estimated 1,700 SOVs would utilize the HOT lanes during the 4 to 6PM time period rather than driving in the general purpose lanes. This is in addition to the 1,300 HOVs.

The purpose of converting the existing HOV lanes to HOT lanes would be to increase the utilization of the available capacity of the HOV lanes by allowing single occupant vehicles the choice to use the lanes in exchange for paying a toll. This would have the effect of moving traffic out of the existing general purpose lane traffic stream and therefore should provide some measurable congestion relief to the existing general purpose lanes. The other often cited benefit from these projects is that the HOT lane provides a reliable trip when it is needed most. To demonstrate this potential, model output was

## Southbound

| | 6:00-7:00 AM | HOT Lane | | | 7:00-8:00 AM | HOT Lane | | | 8:00-9:00 AM | HOT Lane | | | Total | HOT Lane | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GP | HOV | SOV | Total | GP | HOV | SOV | Total | GP | HOV | SOV | Total | GP | HOV | SOV | Total |
| | 4.5 | 0.0 | 0.0 | 4.5 | 6.7 | 0.0 | 0.0 | 6.7 | 5.3 | 0.0 | 0.0 | 5.3 | 16.4 | 0.0 | 0.0 | 16.4 |
| Kennedy Rd. | | | | | | | | | | | | | | | | |
| | 4.5 | 0.2 | 0.1 | 4.8 | 6.1 | 0.6 | 0.6 | 7.3 | 4.7 | 0.5 | 0.6 | 5.8 | 15.3 | 1.3 | 1.3 | 17.9 |
| Poquonock Ave. | | | | | | | | | | | | | | | | |
| | 4.0 | 0.2 | 0.1 | 4.3 | 5.4 | 0.6 | 0.6 | 6.6 | 4.3 | 0.6 | 0.7 | 5.6 | 13.7 | 1.4 | 1.4 | 16.5 |
| Bloomfield Ave. | | | | | | | | | | | | | | | | |
| | 4.1 | 0.2 | 0.1 | 4.4 | 5.3 | 0.6 | 0.6 | 6.5 | 4.4 | 0.6 | 0.7 | 5.7 | 13.8 | 1.4 | 1.4 | 16.6 |
| Park Ave. | | | | | | | | | | | | | | | | |
| | 4.1 | 0.2 | 0.1 | 4.4 | 5.2 | 0.6 | 0.6 | 6.4 | 4.3 | 0.6 | 0.7 | 5.6 | 13.6 | 1.4 | 1.4 | 16.4 |
| SR 291 | | | | | | | | | | | | | | | | |
| | 4.0 | 0.3 | 0.2 | 4.4 | 5.1 | 0.7 | 0.7 | 6.5 | 4.2 | 0.6 | 0.8 | 5.6 | 13.3 | 1.6 | 1.7 | 16.5 |
| Windsor Ave. | | | | | | | | | | | | | | | | |
| | 3.9 | 0.3 | 0.2 | 4.3 | 5.2 | 0.7 | 0.7 | 6.6 | 4.4 | 0.6 | 0.8 | 5.8 | 13.5 | 1.6 | 1.7 | 16.7 |
| Jennings Rd. | | | | | | | | | | | | | | | | |
| | 4.4 | 0.0 | 0.0 | 4.4 | 6.0 | 0.0 | 0.1 | 6.1 | 5.6 | 0.0 | 0.1 | 5.7 | 16.0 | 0.0 | 0.2 | 16.2 |
| Liebert Rd. | | | | | | | | | | | | | | | | |

## Northbound

| | 6:00-7:00 AM | HOT Lane | | | 7:00-8:00 AM | HOT Lane | | | 8:00-9:00 AM | HOT Lane | | | Total | HOT Lane | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GP | HOV | SOV | Total | GP | HOV | SOV | Total | GP | HOV | SOV | Total | GP | HOV | SOV | Total |
| | 3.4 | 0.0 | 0.0 | 3.4 | 4.3 | 0.0 | 0.0 | 4.3 | 3.7 | 0.0 | 0.0 | 3.7 | 11.4 | 0.0 | 0.0 | 11.4 |
| Kennedy Rd. | | | | | | | | | | | | | | | | |
| | 3.5 | 0.2 | 0.1 | 3.7 | 4.6 | 0.3 | 0.2 | 5.0 | 3.9 | 0.2 | 0.2 | 4.2 | 12.0 | 0.7 | 0.5 | 13.2 |
| Poquonock Ave. | | | | | | | | | | | | | | | | |
| | 3.5 | 0.2 | 0.1 | 3.7 | 4.5 | 0.3 | 0.2 | 4.9 | 4.2 | 0.2 | 0.2 | 4.5 | 12.2 | 0.7 | 0.5 | 13.4 |
| Bloomfield Ave. | | | | | | | | | | | | | | | | |
| | 4.3 | 0.3 | 0.1 | 4.6 | 5.4 | 0.3 | 0.2 | 5.8 | 5.3 | 0.2 | 0.2 | 5.6 | 15.0 | 0.8 | 0.5 | 16.3 |
| Park Ave. | | | | | | | | | | | | | | | | |
| | 4.5 | 0.3 | 0.1 | 4.8 | 5.6 | 0.3 | 0.2 | 6.0 | 5.4 | 0.2 | 0.2 | 5.7 | 15.5 | 0.8 | 0.5 | 16.8 |
| SR 291 | | | | | | | | | | | | | | | | |
| | 3.5 | 0.3 | 0.1 | 3.8 | 4.3 | 0.3 | 0.2 | 4.7 | 4.4 | 0.2 | 0.2 | 4.7 | 12.2 | 0.8 | 0.5 | 13.5 |
| Windsor Ave. | | | | | | | | | | | | | | | | |
| | 3.5 | 0.3 | 0.1 | 3.8 | 4.4 | 0.3 | 0.2 | 4.8 | 4.6 | 0.2 | 0.2 | 4.9 | 12.5 | 0.8 | 0.5 | 13.8 |
| Jennings Rd. | | | | | | | | | | | | | | | | |
| | 4.5 | 0.0 | 0.0 | 4.5 | 5.7 | 0.0 | 0.0 | 5.7 | 5.6 | 0.0 | 0.0 | 5.6 | 15.8 | 0.0 | 0.0 | 15.8 |
| Liebert Rd. | | | | | | | | | | | | | | | | |

I-91

00.0 - Estimated Average Weekday Traffic (in thousands)

▬ - Toll Gantry

# ALTERNATIVE 7 - AM PEAK PERIOD
# 2020 ESTIMATED AVERAGE WEEKDAY TRAFFIC - I-91 HOT LANES

CDM Smith

FIGURE ES-18

## Southbound

| I-91 | 3:00-4:00 PM | | | | 4:00-6:00 PM | | | | 6:00-7:00 PM | | | | Total | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HOV Lane | | | | HOV Lane | | | | HOV Lane | | | | HOV Lane | | |
| | GP | HOV | SOV | Total | GP | HOV | SOV | Total | GP | HOV | SOV | Total | GP | HOV | SOV | Total |
| | 4.5 | 0.0 | 0.0 | 4.5 | 9.8 | 0.0 | 0.0 | 9.8 | 3.3 | 0.0 | 0.0 | 3.3 | 17.6 | 0.0 | 0.0 | 17.6 |
| Kennedy Rd. | | | | | | | | | | | | | | | | |
| | 4.3 | 0.4 | 0.3 | 5.0 | 9.1 | 0.9 | 1.0 | 11.0 | 3.1 | 0.3 | 0.3 | 3.7 | 16.5 | 1.6 | 1.6 | 19.7 |
| Poquonock Ave. | | | | | | | | | | | | | | | | |
| | 4.6 | 0.4 | 0.3 | 5.3 | 9.8 | 1.0 | 1.2 | 12.0 | 3.4 | 0.3 | 0.3 | 4.0 | 17.8 | 1.7 | 1.8 | 21.3 |
| Bloomfield Ave. | | | | | | | | | | | | | | | | |
| | 5.3 | 0.5 | 0.3 | 6.1 | 10.7 | 1.2 | 1.5 | 13.4 | 3.7 | 0.4 | 0.3 | 4.4 | 19.7 | 2.1 | 2.1 | 23.9 |
| Park Ave. | | | | | | | | | | | | | | | | |
| | 5.5 | 0.5 | 0.3 | 6.3 | 10.7 | 1.2 | 1.5 | 13.4 | 3.9 | 0.4 | 0.3 | 4.6 | 20.1 | 2.1 | 2.1 | 24.3 |
| SR 291 | | | | | | | | | | | | | | | | |
| | 4.6 | 0.5 | 0.3 | 5.4 | 8.8 | 1.2 | 1.5 | 11.5 | 3.5 | 0.4 | 0.3 | 4.2 | 16.9 | 2.1 | 2.1 | 21.1 |
| Windsor Ave. | | | | | | | | | | | | | | | | |
| | 4.6 | 0.5 | 0.3 | 5.4 | 8.9 | 1.2 | 1.5 | 11.6 | 3.6 | 0.4 | 0.3 | 4.3 | 17.1 | 2.1 | 2.1 | 21.3 |
| Jennings Rd. | | | | | | | | | | | | | | | | |
| | 5.9 | 0.0 | 0.0 | 5.9 | 12.5 | 0.1 | 0.1 | 12.7 | 4.6 | 0.0 | 0.0 | 4.6 | 23.0 | 0.1 | 0.1 | 23.2 |
| Liebert Rd. | | | | | | | | | | | | | | | | |

## Northbound

| I-91 | 3:00-4:00 PM | | | | 4:00-6:00 PM | | | | 6:00-7:00 PM | | | | Total | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | HOV Lane | | | | HOV Lane | | | | HOV Lane | | | | HOV Lane | | |
| | GP | HOV | SOV | Total | GP | HOV | SOV | Total | GP | HOV | SOV | Total | GP | HOV | SOV | Total |
| | 5.8 | 0.0 | 0.0 | 5.8 | 13.8 | 0.0 | 0.0 | 13.8 | 4.0 | 0.0 | 0.0 | 4.0 | 23.6 | 0.0 | 0.0 | 23.6 |
| Kennedy Rd. | | | | | | | | | | | | | | | | |
| | 6.0 | 0.3 | 0.5 | 6.8 | 14.1 | 1.2 | 1.0 | 16.3 | 4.0 | 0.2 | 0.2 | 4.4 | 24.1 | 1.7 | 1.7 | 27.5 |
| Poquonock Ave. | | | | | | | | | | | | | | | | |
| | 5.0 | 0.3 | 0.5 | 5.8 | 10.8 | 1.2 | 1.0 | 13.0 | 3.8 | 0.2 | 0.2 | 4.2 | 19.6 | 1.7 | 1.7 | 23.0 |
| Bloomfield Ave. | | | | | | | | | | | | | | | | |
| | 5.6 | 0.3 | 0.5 | 6.4 | 11.7 | 1.2 | 1.1 | 14.0 | 4.2 | 0.2 | 0.2 | 4.6 | 21.5 | 1.7 | 1.8 | 25.0 |
| Park Ave. | | | | | | | | | | | | | | | | |
| | 5.8 | 0.3 | 0.5 | 6.6 | 12.0 | 1.2 | 1.1 | 14.3 | 4.3 | 0.2 | 0.2 | 4.7 | 22.1 | 1.7 | 1.8 | 25.6 |
| SR 291 | | | | | | | | | | | | | | | | |
| | 5.3 | 0.3 | 0.5 | 6.1 | 11.0 | 1.3 | 1.1 | 13.4 | 4.2 | 0.2 | 0.2 | 4.6 | 20.5 | 1.8 | 1.8 | 24.1 |
| Windsor Ave. | | | | | | | | | | | | | | | | |
| | 5.5 | 0.3 | 0.5 | 6.3 | 11.4 | 1.3 | 1.1 | 13.8 | 4.4 | 0.2 | 0.2 | 4.8 | 21.3 | 1.8 | 1.8 | 24.9 |
| Jennings Rd. | | | | | | | | | | | | | | | | |
| | 6.5 | 0.0 | 0.0 | 6.5 | 13.0 | 0.1 | 0.1 | 13.2 | 4.5 | 0.0 | 0.0 | 4.5 | 24.0 | 0.1 | 0.1 | 24.2 |
| Liebert Rd. | | | | | | | | | | | | | | | | |

00.0 - Estimated Average Weekday Traffic (in thousands)

- Toll Gantry

# ALTERNATIVE 7 - PM PEAK PERIOD
# 2020 ESTIMATED AVERAGE WEEKDAY TRAFFIC - I-91 HOT LANES

CDM Smith

FIGURE ES-19

## Westbound

| | 6:00-7:00 AM | HOV Lane | | | 7:00-8:00 AM | HOV Lane | | | 8:00-9:00 AM | HOV Lane | | | Total | HOV Lane | | | I-84 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GP | HOV | SOV | Total | GP | HOV | SOV | Total | GP | HOV | SOV | Total | GP | HOV | SOV | Total | |
| | | | | | | | | | | | | | | | | | Dobson Rd. |
| | 3.5 | 0.0 | 0.0 | 3.5 | 6.1 | 0.0 | 0.0 | 6.1 | 5.2 | 0.0 | 0.0 | 5.2 | 14.8 | 0.0 | 0.0 | 14.8 | |
| | | | | | | | | | | | | | | | | | Hartford Tpke. |
| | 4.1 | 0.1 | 0.0 | 4.2 | 6.5 | 0.3 | 0.4 | 7.2 | 5.6 | 0.4 | 0.2 | 6.2 | 16.2 | 0.8 | 0.6 | 17.6 | |
| | | | | | | | | | | | | | | | | | SR 30 |
| | 4.5 | 0.1 | 0.0 | 4.6 | 7.3 | 0.3 | 0.4 | 8.0 | 6.1 | 0.4 | 0.2 | 6.7 | 17.9 | 0.8 | 0.6 | 19.3 | |
| | | | | | | | | | | | | | | | | | Pleasant Valley Rd. |
| | 4.2 | 0.1 | 0.1 | 4.4 | 6.8 | 0.4 | 0.5 | 7.7 | 5.7 | 0.5 | 0.4 | 6.6 | 16.7 | 1.0 | 1.0 | 18.7 | |
| | | | | | | | | | | | | | | | | | US 44 |
| | 4.1 | 0.1 | 0.1 | 4.3 | 7.4 | 0.4 | 0.5 | 8.3 | 6.1 | 0.5 | 0.4 | 7.0 | 17.6 | 1.0 | 1.0 | 19.6 | |
| | | | | | | | | | | | | | | | | | I-384 |
| | 6.3 | 0.2 | 0.2 | 6.7 | 10.6 | 0.7 | 0.8 | 12.1 | 9.1 | 0.8 | 0.7 | 10.6 | 26.0 | 1.7 | 1.7 | 29.4 | Toll Gantry |
| | | | | | | | | | | | | | | | | | SR 15 |
| | 3.8 | 0.0 | 0.0 | 3.8 | 6.4 | 0.0 | 0.0 | 6.4 | 5.6 | 0.0 | 0.0 | 5.6 | 15.8 | 0.0 | 0.0 | 15.8 | |

## Eastbound

| I-84 | 6:00-7:00 AM | HOV Lane | | | 7:00-8:00 AM | HOV Lane | | | 8:00-9:00 AM | HOV Lane | | | Total | HOV Lane | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GP | HOV | SOV | Total | GP | HOV | SOV | Total | GP | HOV | SOV | Total | GP | HOV | SOV | Total |
| Dobson Rd. | | | | | | | | | | | | | | | | |
| | 1.3 | 0.0 | 0.0 | 1.3 | 2.2 | 0.0 | 0.0 | 2.2 | 2.2 | 0.0 | 0.0 | 2.2 | 5.8 | 0.0 | 0.0 | 5.8 |
| Hartford Tpke. | | | | | | | | | | | | | | | | |
| | 1.6 | 0.0 | 0.0 | 1.6 | 2.7 | 0.0 | 0.0 | 2.7 | 2.7 | 0.0 | 0.0 | 2.7 | 7.0 | 0.0 | 0.0 | 7.1 |
| SR 30 | | | | | | | | | | | | | | | | |
| | 1.8 | 0.0 | 0.0 | 1.8 | 2.9 | 0.0 | 0.0 | 2.9 | 3.0 | 0.0 | 0.0 | 3.0 | 7.8 | 0.0 | 0.0 | 7.8 |
| Pleasant Valley Rd. | | | | | | | | | | | | | | | | |
| | 1.7 | 0.1 | 0.1 | 1.9 | 2.8 | 0.1 | 0.1 | 3.0 | 2.8 | 0.1 | 0.1 | 3.0 | 7.3 | 0.3 | 0.3 | 7.9 |
| US 44 | | | | | | | | | | | | | | | | |
| | 1.8 | 0.1 | 0.1 | 2.0 | 2.9 | 0.1 | 0.1 | 3.1 | 3.1 | 0.1 | 0.1 | 3.3 | 7.8 | 0.3 | 0.3 | 8.4 |
| I-384 | | | | | | | | | | | | | | | | |
| Toll Gantry | 2.5 | 0.1 | 0.1 | 2.7 | 3.9 | 0.1 | 0.1 | 4.1 | 4.1 | 0.1 | 0.1 | 4.3 | 10.4 | 0.3 | 0.3 | 11.0 |
| SR 15 | | | | | | | | | | | | | | | | |
| | 1.8 | 0.0 | 0.0 | 1.8 | 2.8 | 0.0 | 0.0 | 2.8 | 3.2 | 0.0 | 0.0 | 3.2 | 7.8 | 0.0 | 0.0 | 7.8 |

00.0 - Estimated Average Weekday Traffic (in thousands)

▬ - Toll Gantry

CDM Smith

# ALTERNATIVE 7 - AM PEAK PERIOD
# 2020 ESTIMATED AVERAGE WEEKDAY TRAFFIC - I-84 HOT LANES

FIGURE ES-20

| Westbound | | | | | | | | | | | | | | | | I-84 | Eastbound | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3:00-4:00 PM | | | | 4:00-6:00 PM | | | | 6:00-7:00 PM | | | | Total | | | | 84 | 3:00-4:00 PM | | | | 4:00-6:00 PM | | | | 6:00-7:00 PM | | | | Total | | | |
| | HOV Lane | | | | HOV Lane | | | | HOV Lane | | | | HOV Lane | | | | | HOV Lane | | | | HOV Lane | | | | HOV Lane | | | | HOV Lane | | |
| GP | HOV | SOV | Total | GP | HOV | SOV | Total | GP | HOV | SOV | Total | GP | HOV | SOV | Total | | GP | HOV | SOV | Total | GP | HOV | SOV | Total | GP | HOV | SOV | Total | GP | HOV | SOV | Total |
| | | | | | | | | | | | | | | | | Dobson Rd. | | | | | | | | | | | | | | | | |
| 3.3 | 0.0 | 0.0 | 3.3 | 6.8 | 0.0 | 0.0 | 6.8 | 2.3 | 0.0 | 0.0 | 2.3 | 12.4 | 0.0 | 0.0 | 12.4 | | 4.2 | 0.0 | 0.0 | 4.2 | 10.2 | 0.0 | 0.0 | 10.2 | 3.4 | 0.0 | 0.0 | 3.4 | 17.8 | 0.0 | 0.0 | 17.8 |
| | | | | | | | | | | | | | | | | Hartford Tpke. | | | | | | | | | | | | | | | | |
| 3.8 | 0.1 | 0.0 | 3.9 | 7.9 | 0.2 | 0.0 | 8.1 | 2.8 | 0.1 | 0.0 | 2.9 | 14.5 | 0.4 | 0.0 | 14.9 | | 4.9 | 0.1 | 0.2 | 5.2 | 11.7 | 0.6 | 0.9 | 13.2 | 4.3 | 0.1 | 0.1 | 4.5 | 20.9 | 0.8 | 1.2 | 22.9 |
| | | | | | | | | | | | | | | | | SR 30 | | | | | | | | | | | | | | | | |
| 4.1 | 0.1 | 0.0 | 4.2 | 8.4 | 0.2 | 0.0 | 8.6 | 3.0 | 0.1 | 0.0 | 3.1 | 15.5 | 0.4 | 0.0 | 15.9 | | 5.5 | 0.1 | 0.2 | 5.8 | 13.3 | 0.6 | 0.9 | 14.8 | 4.6 | 0.1 | 0.1 | 4.8 | 23.4 | 0.8 | 1.2 | 25.4 |
| | | | | | | | | | | | | | | | | Pleasant Valley Rd. | | | | | | | | | | | | | | | | |
| 3.7 | 0.1 | 0.3 | 4.1 | 7.5 | 0.3 | 0.6 | 8.4 | 2.5 | 0.1 | 0.1 | 2.7 | 13.7 | 0.5 | 1.0 | 15.2 | | 5.0 | 0.2 | 0.4 | 5.6 | 12.3 | 0.8 | 1.1 | 14.2 | 4.1 | 0.2 | 0.1 | 4.4 | 21.4 | 1.2 | 1.6 | 24.2 |
| | | | | | | | | | | | | | | | | US 44 | | | | | | | | | | | | | | | | |
| 3.8 | 0.1 | 0.3 | 4.2 | 7.6 | 0.3 | 0.6 | 8.5 | 2.6 | 0.1 | 0.1 | 2.8 | 14.0 | 0.5 | 1.0 | 15.5 | | 5.5 | 0.2 | 0.4 | 6.1 | 13.2 | 0.8 | 1.1 | 15.1 | 4.5 | 0.2 | 0.1 | 4.8 | 23.2 | 1.2 | 1.6 | 26.0 |
| | | | | | | | | | | | | | | | | I-384 | | | | | | | | | | | | | | | | |
| 5.2 | 0.2 | 0.3 | 5.7 | 10.3 | 0.4 | 0.6 | 11.3 | 3.7 | 0.2 | 0.2 | 4.1 | 19.2 | 0.8 | 1.1 | 21.1 | (Toll Gantry) | 7.5 | 0.3 | 0.5 | 8.3 | 17.7 | 1.3 | 1.7 | 20.7 | 5.9 | 0.3 | 0.2 | 6.4 | 31.1 | 1.9 | 2.4 | 35.4 |
| | | | | | | | | | | | | | | | | SR 15 | | | | | | | | | | | | | | | | |
| 3.4 | 0.0 | 0.0 | 3.4 | 6.5 | 0.0 | 0.0 | 6.5 | 2.2 | 0.0 | 0.0 | 2.2 | 12.1 | 0.0 | 0.0 | 12.1 | | 5.6 | 0.0 | 0.0 | 5.6 | 14.0 | 0.0 | 0.0 | 14.0 | 4.2 | 0.0 | 0.0 | 4.2 | 23.8 | 0.0 | 0.0 | 23.8 |

00.0 - Estimated Average Weekday Traffic (in thousands)

- Toll Gantry

CDM Smith

# ALTERNATIVE 7 - PM PEAK PERIOD
# 2020 ESTIMATED AVERAGE WEEKDAY TRAFFIC - I-84 HOT LANES

FIGURE ES-21

summarized for two conditions; operation of the HOV lanes as they exist today versus a HOT lane operation.

**Table ES-1** shows 2020 estimated average travel speeds along the general purpose lanes and the HOV or HOT lanes for the AM and PM peaks over the limits of the project. The top half of the table shows the average speeds under a continued operation of the HOV lanes, while the bottom half of the table shows the estimated average speeds under a HOT operation. The left half of the table shows results for the I-91 corridor, while the right half displays the results for the I-84 corridor. The shading highlights the peak periods.

The I-91 southbound general purpose (GP) travel speeds in the southbound direction under current HOV operation are estimated to operate at 46 mph during both the 8 to 9AM hour and the 4 to 6PM period. Under HOT operation, these general purpose lane speeds are estimated to increase to 54 and 55 mph, respectively. The northbound general purpose lane travel speeds during the 4 to 6PM time period are estimated to increase from 51 mph under an HOV operation to 56 mph during a HOT operation.

The I-84 westbound general purpose (GP) travel speeds under current HOV operation are estimated to operate at 50 mph during the 7 to 8AM hour. Under HOT operation, these general purpose lane speeds are estimated to increase to 54mph. The eastbound general purpose lane travel speeds during the 4 to 6PM time period are estimated to increase from 51 mph under an HOV operation to 55 mph during a HOT operation.

**Table ES-1**
**Alternative 7: 2020 I-91 and I-84 Estimated Speeds**
**HOV versus HOT Operation**

| Time Period | I-91 Average Travel Speed - Current HOV operation | | | | | | I-84 Average Travel Speed - Current HOV operation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I-91 Southbound | | | I-91 Northbound | | | I-84 Westbound | | | I-84 Eastbound | | |
| | GP | HOV | Total | GP | HOV | Total | GP | HOV | Total | GP | HOV | Total |
| 6:00-7:00 | 66 | 70 | 66 | 67 | 70 | 68 | 66 | 70 | 66 | 67 | 70 | 67 |
| 7:00-8:00 | 48 | 69 | 49 | 65 | 70 | 65 | 50 | 70 | 51 | 67 | 70 | 67 |
| 8:00-9:00 | 46 | 70 | 47 | 65 | 70 | 65 | 59 | 69 | 60 | 66 | 70 | 67 |
| 9:00-3:00 | 64 | 70 | 65 | 66 | 70 | 66 | 67 | 70 | 67 | 66 | 70 | 66 |
| 3:00-4:00 | 61 | 70 | 61 | 55 | 70 | 56 | 67 | 70 | 67 | 59 | 70 | 60 |
| 4:00-6:00 | 46 | 69 | 48 | 51 | 69 | 52 | 67 | 70 | 67 | 51 | 70 | 52 |
| 6:00-7:00 | 60 | 70 | 60 | 67 | 70 | 67 | 67 | 70 | 67 | 65 | 70 | 65 |
| 7:00-6:00 | 68 | 70 | 68 | 68 | 70 | 68 | 67 | 70 | 67 | 67 | 70 | 67 |

| Time Period | I-91 Average Travel Speed - HOT Operation | | | | | | I-84 Average Travel Speed - HOT Operation | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I-91 Southbound | | | I-91 Northbound | | | I-84 Westbound | | | I-84 Eastbound | | |
| | GP | HOT | Total | GP | HOT | Total | GP | HOT | Total | GP | HOT | Total |
| 6:00-7:00 | 66 | 70 | 67 | 67 | 70 | 68 | 66 | 70 | 66 | 67 | 70 | 67 |
| 7:00-8:00 | 55 | 62 | 56 | 65 | 70 | 65 | 54 | 65 | 55 | 67 | 70 | 67 |
| 8:00-9:00 | 54 | 61 | 56 | 65 | 70 | 65 | 61 | 67 | 62 | 66 | 70 | 67 |
| 9:00-3:00 | 65 | 70 | 66 | 66 | 70 | 66 | 67 | 70 | 67 | 66 | 70 | 66 |
| 3:00-4:00 | 63 | 69 | 64 | 60 | 69 | 61 | 67 | 70 | 67 | 61 | 69 | 62 |
| 4:00-6:00 | 55 | 61 | 56 | 56 | 65 | 58 | 67 | 70 | 67 | 55 | 65 | 56 |
| 6:00-7:00 | 63 | 69 | 63 | 67 | 70 | 67 | 67 | 70 | 67 | 65 | 70 | 65 |
| 7:00-6:00 | 68 | 70 | 68 | 68 | 70 | 68 | 67 | 70 | 67 | 67 | 70 | 67 |

Shading indicates peak hours between 7AM and 9AM and between 4PM and 6PM.

While these potential general purpose lane speed improvements along I-91 and I-84 are quite significant, the southern termini of the existing I-91 and I-84 HOV lanes if converted to HOT lanes should be further evaluated operationally to determine if allowing extra vehicles exiting from the HOT lane would impact highway operations. Physical changes along the southern termini segments of each HOT lane will likely need to be considered in order to mitigate any operational impacts and fully recognize the speed improvements along the general purpose lanes from a HOV to HOT conversion.

## I-84 Hartford Traffic Operations Findings

A special operations model was created in order to assess the potential operational impacts from tolling I-84 in Hartford. The microsimulation model was built to include the transportation network which could be potentially impacted by the alternatives, including local arterials through Hartford. The microsimulation model includes I-84 from Trout Brook Drive (Exit 42) in West Hartford to the Middle Turnpike / U.S. 6 / U.S. 44 (Exit 61) in Manchester. The model also includes portions of I-91 from Brainard Road (Exit 27) to Trumbull Street (Exit 32B). Also included are the connections to I-384, Route 15, and Route 2. The microsimulation model also includes a significant portion of the arterial system in downtown Hartford. **Figure ES-22** highlights in orange the roadways which were explicitly simulated in the model.

**Figure ES-22**
**Simulation Model Geographic Limits**


Source of Aerial Imagery: Google Maps

During analysis of 2040 No-Toll (Toll Free) scenarios, it was recognized that 2040 conditions would see significant increases in congestion far above the already heavily congested conditions of today, even at very modest growth rates. This finding would make the output from the simulation model unstable and of little use due to "gridlock" conditions in portions of the network. The goal of this congestion relief study was not to determine the roadway improvements needed to satisfy 2040 demand conditions, but to estimate the feasibility of adding all electronic tolling on I-84 and the impacts of potential diversions onto the surrounding roadways, including onto Hartford's arterial roadways. Given that the 2040 demands cannot be adequately served by the No Build network or by the preliminary build alternatives as received during the course of this study, the decision was made to examine the tolling impacts under the existing traffic demands conditions (2012 demand levels). As such, all subsequent simulation analyses conducted were simulated using the 2012 demands.

## I-84 Operations Analysis

Two different tolling scenarios were simulated to assess the potential impact of tolling on operations of I-84 and the adjoining arterial streets in Hartford and West Hartford. These included a single point toll (Alternative 1 Tolled) and a scenario with two tolling locations (Alternative 2 Tolled). In both cases, tolling operations would be fully electronic and no toll barriers would exist.

### *Alternative 1 Tolled - Single Point Toll Scenario*

In the point toll scenario, a single toll gantry would be located along the current Aetna viaduct location between the Sigourney Street and Capital Avenue ramps. At the gantry location, a peak period toll of one dollar ($1.00) for a passenger vehicle equipped with a transponder would be charged per vehicle passing the gantry in either the eastbound or westbound direction. Vehicles without a transponder were assumed to be assessed a $1.50 toll to account for the additional cost of processing, mailing, and collecting the toll from video toll users. Trucks would be assessed a proportionally higher toll rate.

**Figure ES-23** displays the Alternative 1 tolling speed contours versus the toll free condition for the AM Peak Period. Under the tolling alternative, a single point toll gantry is located at the existing Aetna Viaduct between the Asylum Street and Sigourney Street ramps. Under these conditions, the Asylum Street off-ramp from I-84 Westbound serves as the last exit before the toll gantry, and sees additional traffic demands from those vehicles trying to avoid paying the toll. During the AM Peak Period under existing conditions (toll free), this off-ramp and the resulting signal delays at Asylum Street and Farmington Avenue are the source of a major bottleneck, with the demand frequently exceeding the storage space on the off-ramp and queues can be seen to spill back and affect the mainline operations of I-84 eastbound. In the AM Peak Period Point Toll simulation conditions, the effects of the additional demand for the Asylum Street off-ramp create even more congestion problems along I-84 westbound. In the eastbound direction during the AM Peak Period, the congestion that does exist on I-84 from the Flatbush on ramp westward is alleviated under the tolled condition as overall demand is reduced under tolling.

**Figure ES-24** displays the Alternative 1 tolling speed contours versus the toll free condition for the PM Peak Period. During the PM Peak Period in the westbound direction, the Alternative 1 Toll Free condition sees the largest bottleneck in the westbound direction approaching at the left hand exit to Flatbush Avenue. Under the Alternative 1 toll scenario, the volume of traffic traveling along westbound I-84 is somewhat reduced due to local diversions to arterial streets and long distance diversion to regional alternatives (e.g. I-684). However, despite the reduced traffic demand, the increased demand for traffic exiting I-84 at the Asylum Street off-ramp to avoid paying the toll creates a new bottleneck that is reminiscent of the bottleneck in the same location in the AM Peak Period. Although more minor in nature than in the AM peak, this can still be seen to create slow moving traffic along I-84 westbound as far east as the tunnel on I-84 in the downtown area. In the PM Peak Period in the eastbound direction, the severe bottleneck seen in the 2012 Alternative 1 Toll Free conditions at the Bulkeley Bridge over the Connecticut River remains in the 2012 Alternative 1 Point Toll scenario. However, due to the slightly reduced volumes for traffic on I-84 from combined arterial and regional

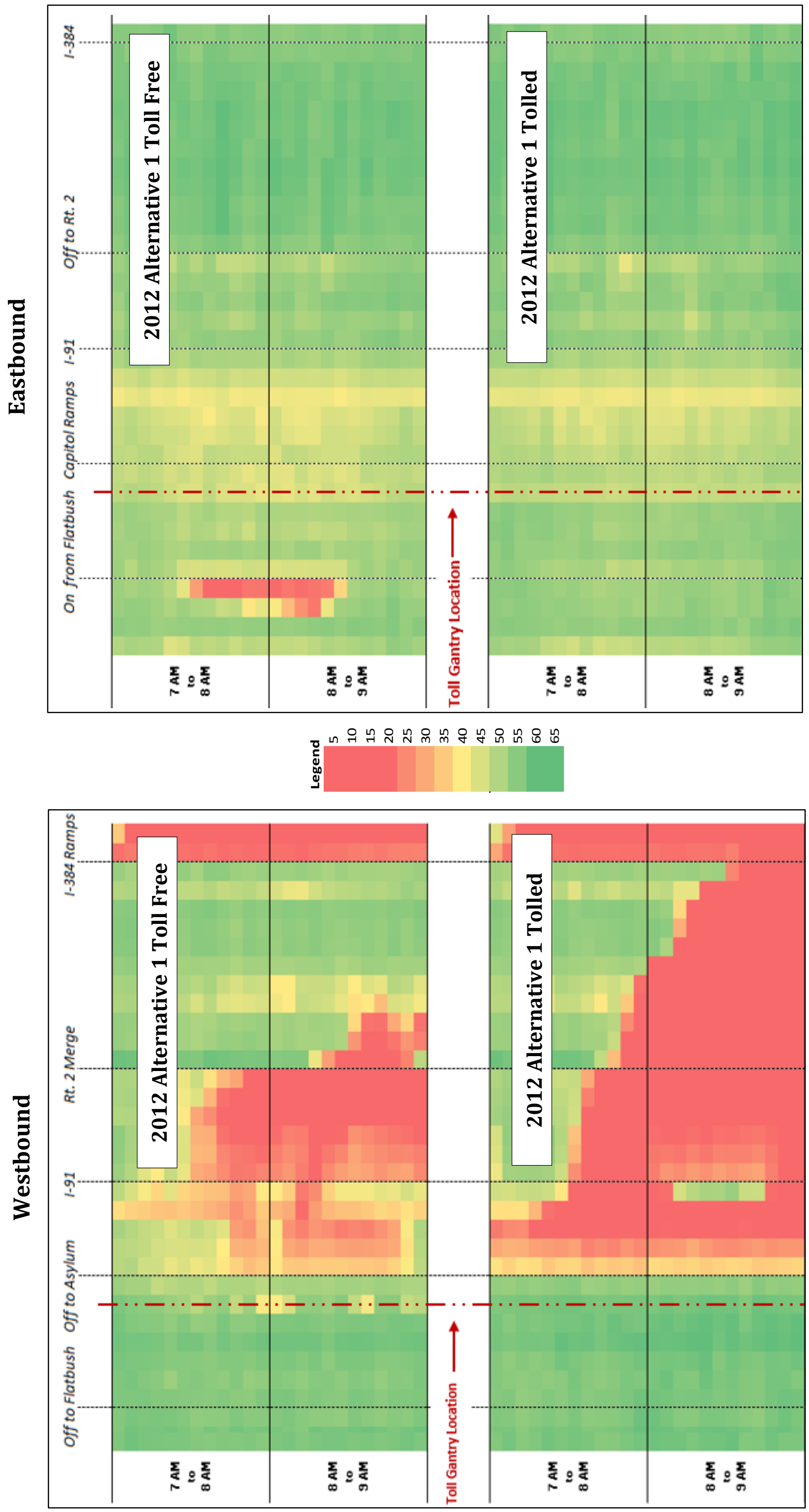



**Figure ES-23**
**I-84 Speed Contours for AM Peak Period**
**Alternative 1 Toll Free Versus Alternative 1 Point Toll**

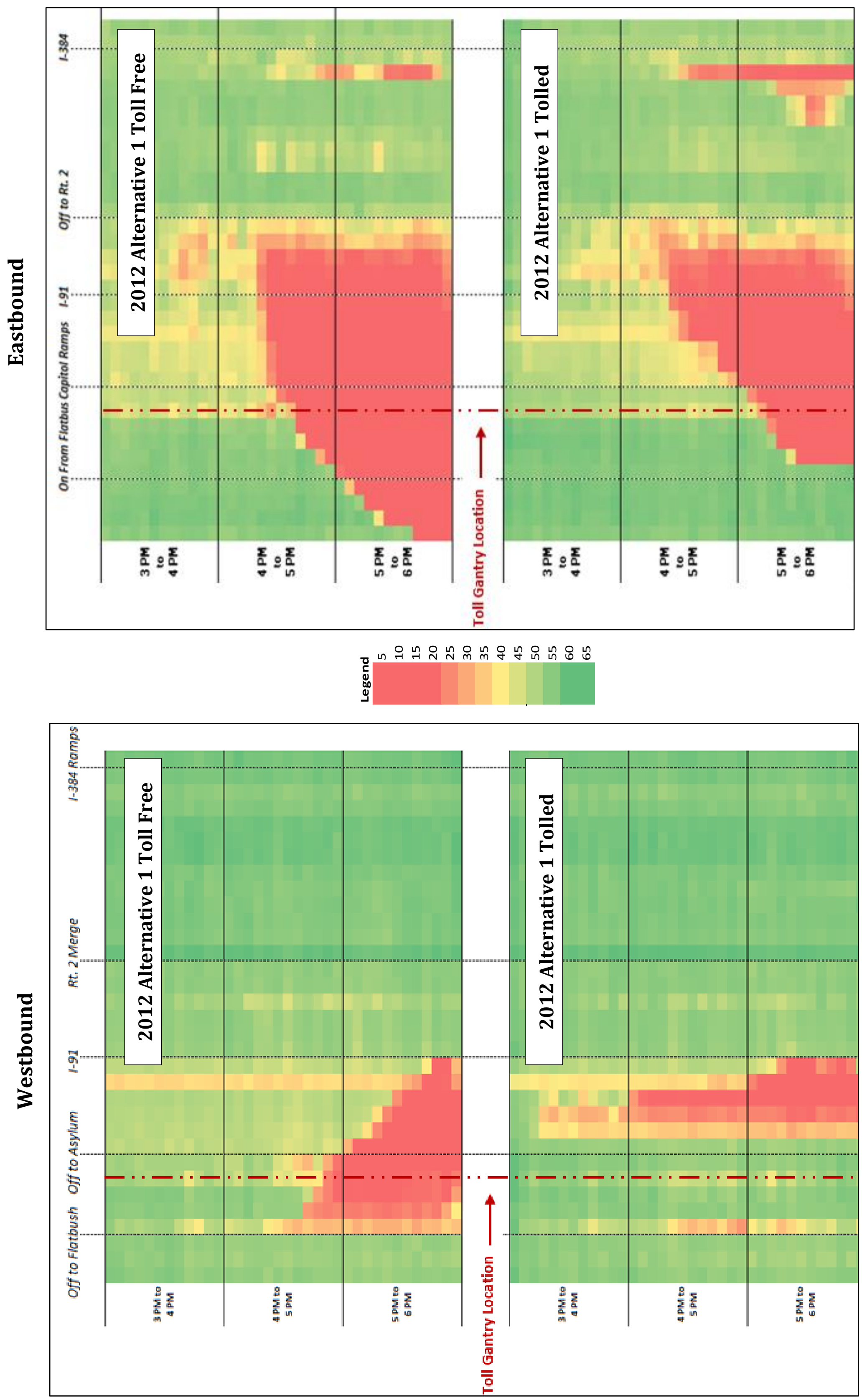



**Figure ES-24**
**I-84 Speed Contours for PM Peak Period**
**Alternative 1 Toll Free Versus Alternative 1 Point Toll**

toll diversions, the bottleneck, while still severe and backing up for miles, is reduced over the 2012 Alternative 1 Toll Free conditions.

### *Alternative 2 Tolled - Two Tolling Locations Scenario*

In the two tolling locations scenario, two separate toll gantries would be implemented and located east of the westbound I-84 Asylum Street off-ramp, and west of the West Boulevard ramps. At each gantry location, a fifty cent ($0.50) peak period toll would be collected in either direction. While the overall toll for a through trip on I-84 would remain the same as for the single point toll scenario, splitting the toll into two collection points could reduce diversion impacts for local Hartford-based traffic.

**Figure ES-25** displays the Alternative 2 tolling speed contours versus the toll free condition for the AM Peak Period. In the westbound direction, I-84 sees large operational improvements at the Asylum off-ramp, with traffic now flowing near free flow conditions throughout the AM Peak Period. This improvement in operations is caused by the combined reduction in the demand from traffic diverting from the toll locations. This diversion traffic takes two forms; first, regional diversions which avoid the I-84 Corridor through Hartford, and second, local diversion traffic. For local diversion traffic, drivers avoid paying the toll at the first gantry location east of Asylum off ramp by exiting at the previous off-ramp to Main Street immediately upstream of the first toll gantry location. Drivers trying to get to the downtown Hartford area use the Main Street off-ramp to Chapel Street, and then have to make a left turn at either Market Street, Main Street or Trumbull Street to reach the downtown area, while more westerly destined trips continue along Chapel Street and then seek to turn left at Pleasant Street or High Street. All these intersections have limited left turn capacity, and even with timing adjustments to increate left turn capacities, the signals are not able to accommodate the additional diverted traffic and eventually queues extend along Main Street and back onto the I-84 mainline. Immediately downstream of the Bulkeley Bridge, the four travel lanes of I-84 split to feed the off-ramp to I-91 Northbound and the Main Street off-ramp, with only two lanes continuing on I-84. These diverges are very closely spaced, and create additional weaving friction as vehicles position themselves in the correct lane. When the Main Street off-ramp queue eventually spills back to the I-84 Mainline, this weaving becomes increasing more difficult, and queues quickly build on I-84. In the eastbound direction, operations in the AM Peak Period improve slightly under the tolled condition, as the reduced I-84 demand eliminates the minor 2012 Alternative 1 Toll Free bottleneck approaching Flatbush Avenue, and the entire corridor to operates at or near free flow speed conditions.

**Figure ES-26** displays the Alternative 2 tolling speed contours versus the toll free condition for the PM Peak Period. In the westbound direction, operations at the Flatbush Avenue bottleneck improve as the toll diversions reduce the throughput demand at this location. While the bottleneck does still form, it occurs later in the PM Peak Period and is lessened in its severity. In the eastbound direction, the major bottleneck approaching the Bulkeley Bridge over the Connecticut River continues to form and create severe congestion, although the effects of the congestion are somewhat improved due to the reduction in demand to cross the Bulkeley Bridge. The bottleneck west of the I-384 diverge, which is caused by merging and weaving vehicles approaching the I-384 diverge, is increased in severity. This bottleneck is worsened as diverted traffic joins back onto I-84 after crossing the Connecticut River at the Founders Bridge (local diversion traffic) or the Charter Oak Bridge (regional diversions). The additional demands on merging and weaving along I-84 approaching the I-384 diverge create a moderate increase in the bottleneck severity.

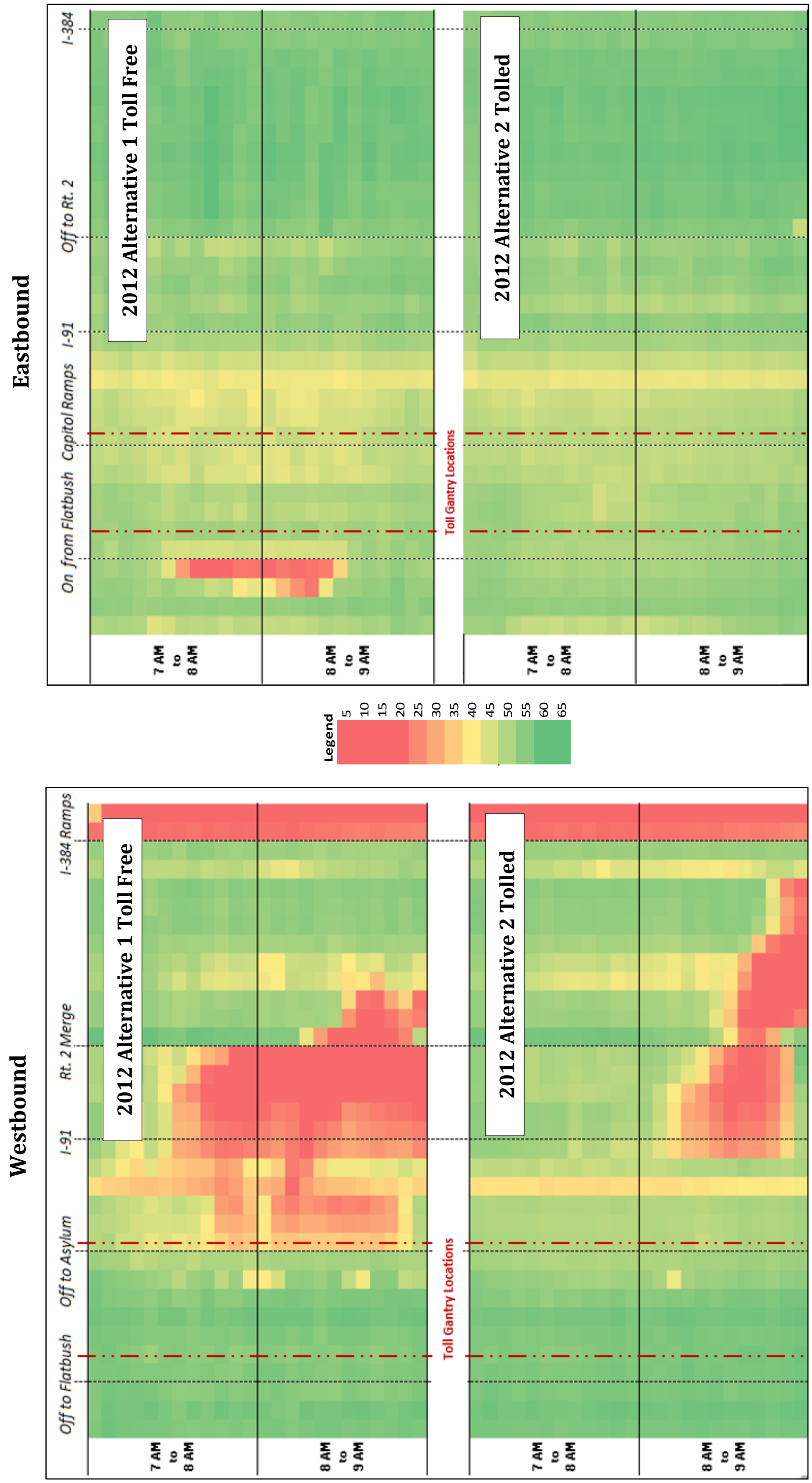



**Figure ES-25**
**I-84 Speed Contours for AM Peak Period**
**Alternative 1 Toll Free Versus Alternative 2 Tolled**

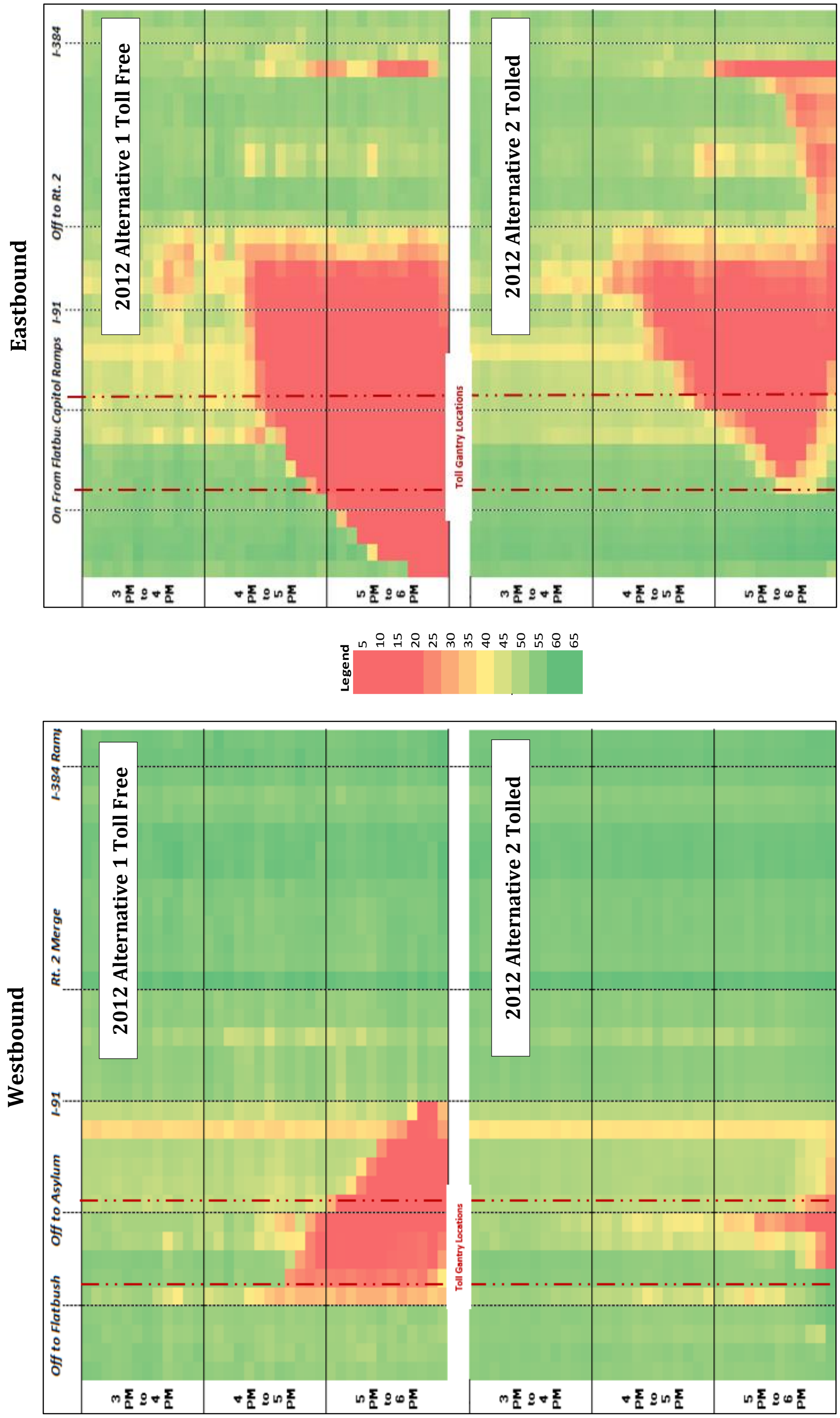



**Figure ES-26**
**I-84 Speed Contours for PM Peak Period**
**Alternative 1 Toll Free Versus Alternative 2 Tolled**

## Systemwide Performance Measures

While the previous sections quantified the impacts of tolling on the I-84 freeway operations, the operational impacts on the arterials and local roadways were also examined. Vehicle miles travelled (VMT), vehicle hours travelled (VHT), and average travel speeds were summarized for the simulated area. **Figure ES-27** presents average travel speeds for different classes of roadways throughout the AM and PM Peak Periods for the 2012 No Build (Alternative 1 Toll Free), 2012 Single Point Toll (Alternative 1 Tolled), and 2012 Two Tolling Locations (Alternative 2 Tolled) scenarios.

In the 2012 Single Point Toll scenario, westbound traffic seeks to exit from I-84 predominately at the Asylum Street off-ramp and use alternative local diversion routes through the surface street network to avoid paying the toll. Similarly, eastbound traffic on I-84 exits early at Prospect Avenue to avoid the point toll gantry along the viaduct. In the 2012 Split Toll scenario, local diversion traffic is somewhat more dispersed, but the network still sees diversion traffic exiting westbound I-84 onto the Main Street off-ramp and eastbound off-ramp traffic at Prospect Avenue and Capital Avenue. Under both tolling scenarios, from these exit points, the local diversion traffic will use the surface street arterial network to complete their trips, with relatively significant increases in traffic seen along the major east-west arterials, including Farmington Avenue, Capital Avenue, Park Street, and Chapel Street.

In both the AM and PM Peak Periods, this local diversion traffic creates additional demand for the arterial and local street roadways, some which are already operating at or near capacity during peak conditions. While the simulation analyses considered minor additional improvements such as re-striping of turn lanes or addition or extension of turn bays which would not likely require right-of-way takings or major construction efforts, the arterial system still operates at capacity in key locations and significant increases in congestion can be seen, and results in the decrease of the arterial and local roadway average speeds. In both conditions, this effect is more impactful in lowering the operational conditions on the arterial in the already more congested PM Peak Period.

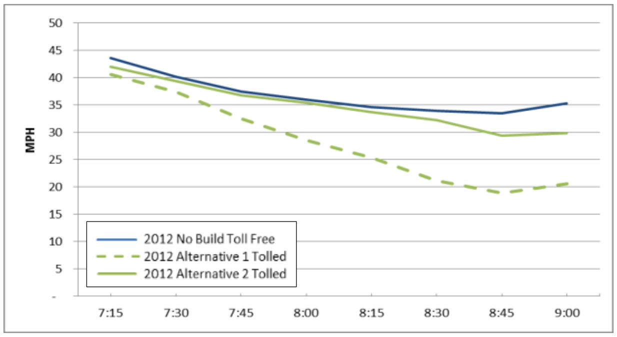
These impacts are much more significant in the Point Toll scenario where the diversion vehicles are more concentrated and add to an already oversaturated operating condition at the Asylum Street off-ramp. While these problems may possibly be resolved with a redesign of the Asylum Avenue, Farmington Avenue, and Broad Street intersections, significant improvements would likely be needed. Overall in the AM Peak Period, the total VMT on the study area roadways increased on the arterials and local roadways, with more substantial increases in VHT and decreases in the average speed. This effect is even stronger in the PM Peak Period, with average travel speeds across the entire surface street network dropping by more than half during the core of the peak period.

The Two Toll Location scenario (Alternative 2) operates better that the Single Point Toll scenario (Alternative 1) as the vehicles avoiding to pay the toll are spread across more exits as compared to the point toll scenario. An additional benefit of the two tolling locations is that it discourages travel on the already congested Asylum Street off-ramp. While that traffic primarily diverts to the Main Street off-ramp (Exit 50), there could be better opportunities to add capacity along Chapel Street to accommodate the increase in demand.

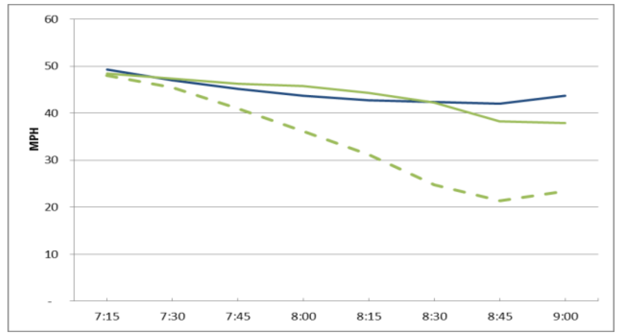
Overall, during the AM Peak Period in the Two Tolling Location scenario, the operations on the arterials see more demand, with VHT increases and average speed decreases. However, the local roadways do not see as large of a deterioration of operational conditions, which is an indication that the arterial roadways are better able to serve the additional local diversion traffic without that traffic seeking even lower class roadways to avoid increased congestion. During the PM Peak Period,

**Figure ES-27**
**Average Travel Speeds**

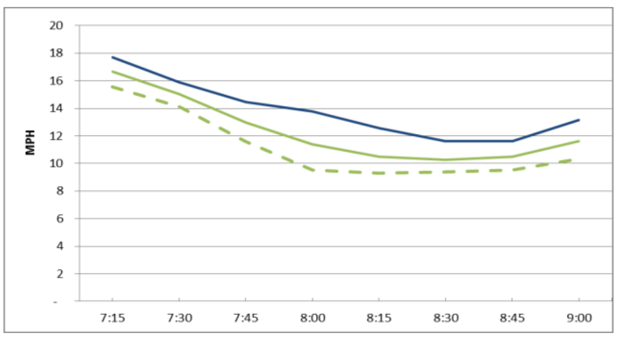
**AM Peak Period**



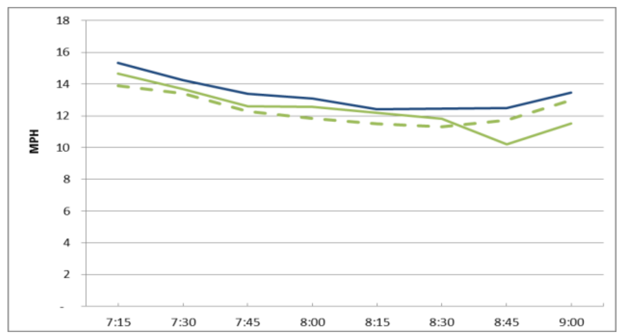

**Network Wide**




**Freeway and Ramps**

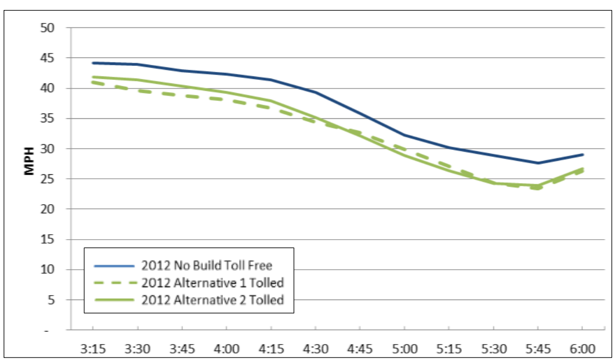



**Arterial Streets**

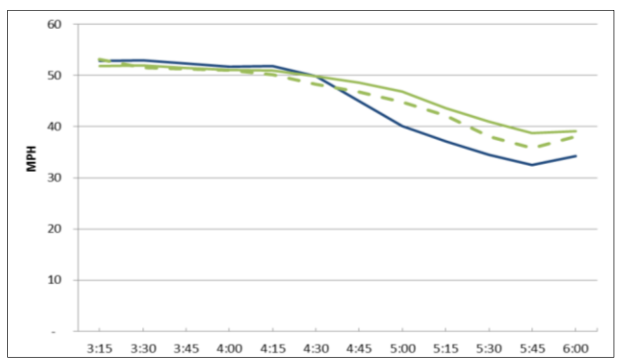



**Local and Collector Streets**

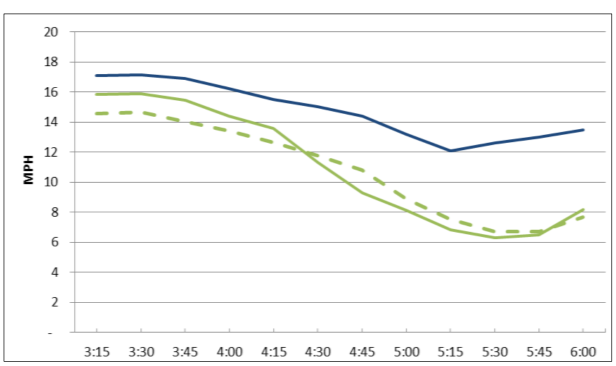
**PM Peak Period**



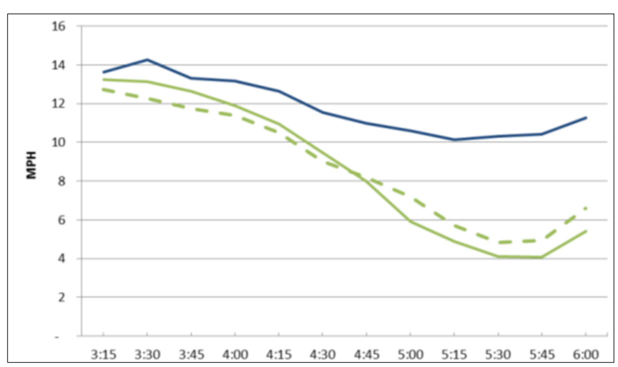

**Network Wide**




**Freeway and Ramps**




**Arterial Streets**




**Local and Collector Streets**

however, the increase in VHT and decrease in average speeds are relatively close in relative magnitude, indicating that the surface street network is saturated and vehicles are seeking even the lowest local class roadways to attempt to avoid congestion on the arterial network.

## Estimated Annual Gross and Net Toll Revenue

Average weekday toll revenue was summarized for each alternative and expanded to reflect an annual estimate for modeled years 2020 and 2040. A 25-year stream of revenue was created by interpolating between the forecast years and extrapolating through 2044. **Table ES-2** shows the 25-year annual trip and gross toll revenue (2014 dollars) stream for Alternatives 1, 2, 3, 4, 5 and 6. 25-year average annual estimates spanning over 2020-2044 are included at the bottom of the table, as well as the annual percent growth rate during this period. Alternative 1 is estimated to produce 46.3 million trips and yield $44.7 million in toll revenue annually on average over the 25-year span. Alternative 2 is estimated to produce 55.5 million trips and $42.9 million in toll revenue annually on average. Alternative 3 is estimated to produce 39.8 million trips and $38.0 million in toll revenue annually on average. Alternative 4 is estimated to produce 54.3 million trips and $41.8 million in toll revenue annually on average. Alternative 5 is estimated to produce 56.4 million trips and $43.6 million in toll revenue annually on average. Alternative 6 is estimated to produce 160.2 million trips and $186.8 million in toll revenue annually on average. The estimated toll revenue for Alternative 6 is approximately 4 to 5 times higher than the other alternatives.

**Table ES-2**
**Estimated Annual Trips and Toll Revenue**

| | Alternative 1 | | Alternative 2 | | Alternative 3 | | Alternative 4 | | Alternative 5 | | Alternative 6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Annual Toll Trips | Annual Gross Toll Revenue | Annual Toll Trips | Annual Gross Toll Revenue | Annual Toll Trips | Annual Gross Toll Revenue | Annual Toll Trips | Annual Gross Toll Revenue | Annual Toll Trips | Annual Gross Toll Revenue | Annual Toll Trips | Annual Gross Toll Revenue |
| 2020 | 43,428,000 | $41,668,000 | 52,649,000 | $40,189,000 | 37,323,000 | $35,411,000 | 51,428,000 | $39,179,000 | 53,440,000 | $40,932,000 | 148,283,000 | $173,102,000 |
| 2021 | 43,659,000 | $41,910,000 | 52,882,000 | $40,403,000 | 37,518,000 | $35,618,000 | 51,658,000 | $39,390,000 | 53,681,000 | $41,147,000 | 149,226,000 | $174,188,000 |
| 2022 | 43,890,000 | $42,153,000 | 53,116,000 | $40,619,000 | 37,713,000 | $35,826,000 | 51,890,000 | $39,602,000 | 53,923,000 | $41,363,000 | 150,175,000 | $175,281,000 |
| 2023 | 44,123,000 | $42,397,000 | 53,351,000 | $40,836,000 | 37,910,000 | $36,036,000 | 52,123,000 | $39,815,000 | 54,165,000 | $41,581,000 | 151,129,000 | $176,380,000 |
| 2024 | 44,358,000 | $42,643,000 | 53,587,000 | $41,054,000 | 38,108,000 | $36,247,000 | 52,356,000 | $40,030,000 | 54,409,000 | $41,799,000 | 152,090,000 | $177,487,000 |
| 2025 | 44,593,000 | $42,890,000 | 53,824,000 | $41,273,000 | 38,306,000 | $36,459,000 | 52,591,000 | $40,245,000 | 54,654,000 | $42,019,000 | 153,057,000 | $178,600,000 |
| 2026 | 44,830,000 | $43,139,000 | 54,062,000 | $41,493,000 | 38,506,000 | $36,672,000 | 52,826,000 | $40,462,000 | 54,901,000 | $42,240,000 | 154,030,000 | $179,721,000 |
| 2027 | 45,068,000 | $43,389,000 | 54,302,000 | $41,714,000 | 38,707,000 | $36,886,000 | 53,063,000 | $40,680,000 | 55,148,000 | $42,462,000 | 155,010,000 | $180,848,000 |
| 2028 | 45,307,000 | $43,641,000 | 54,542,000 | $41,937,000 | 38,909,000 | $37,102,000 | 53,301,000 | $40,899,000 | 55,396,000 | $42,685,000 | 155,995,000 | $181,983,000 |
| 2029 | 45,548,000 | $43,894,000 | 54,783,000 | $42,161,000 | 39,112,000 | $37,319,000 | 53,540,000 | $41,119,000 | 55,646,000 | $42,910,000 | 156,987,000 | $183,125,000 |
| 2030 | 45,789,000 | $44,148,000 | 55,026,000 | $42,385,000 | 39,316,000 | $37,537,000 | 53,780,000 | $41,340,000 | 55,897,000 | $43,135,000 | 157,985,000 | $184,274,000 |
| 2031 | 46,032,000 | $44,404,000 | 55,269,000 | $42,612,000 | 39,521,000 | $37,757,000 | 54,021,000 | $41,563,000 | 56,148,000 | $43,362,000 | 158,990,000 | $185,430,000 |
| 2032 | 46,277,000 | $44,662,000 | 55,514,000 | $42,839,000 | 39,727,000 | $37,977,000 | 54,263,000 | $41,787,000 | 56,401,000 | $43,590,000 | 160,000,000 | $186,593,000 |
| 2033 | 46,522,000 | $44,921,000 | 55,760,000 | $43,068,000 | 39,934,000 | $38,200,000 | 54,506,000 | $42,012,000 | 56,655,000 | $43,819,000 | 161,018,000 | $187,763,000 |
| 2034 | 46,769,000 | $45,181,000 | 56,006,000 | $43,297,000 | 40,142,000 | $38,423,000 | 54,750,000 | $42,238,000 | 56,910,000 | $44,049,000 | 162,041,000 | $188,941,000 |
| 2035 | 47,018,000 | $45,443,000 | 56,254,000 | $43,528,000 | 40,352,000 | $38,648,000 | 54,996,000 | $42,465,000 | 57,167,000 | $44,281,000 | 163,072,000 | $190,127,000 |
| 2036 | 47,267,000 | $45,707,000 | 56,503,000 | $43,761,000 | 40,562,000 | $38,874,000 | 55,242,000 | $42,694,000 | 57,424,000 | $44,514,000 | 164,108,000 | $191,320,000 |
| 2037 | 47,518,000 | $45,972,000 | 56,753,000 | $43,994,000 | 40,774,000 | $39,101,000 | 55,490,000 | $42,924,000 | 57,683,000 | $44,748,000 | 165,152,000 | $192,520,000 |
| 2038 | 47,770,000 | $46,238,000 | 57,004,000 | $44,229,000 | 40,986,000 | $39,330,000 | 55,738,000 | $43,155,000 | 57,943,000 | $44,983,000 | 166,202,000 | $193,728,000 |
| 2039 | 48,024,000 | $46,506,000 | 57,257,000 | $44,465,000 | 41,200,000 | $39,560,000 | 55,988,000 | $43,387,000 | 58,204,000 | $45,219,000 | 167,259,000 | $194,943,000 |
| 2040 | 48,279,000 | $46,776,000 | 57,510,000 | $44,702,000 | 41,415,000 | $39,791,000 | 56,239,000 | $43,621,000 | 58,466,000 | $45,457,000 | 168,322,000 | $196,166,000 |
| 2041 | 48,535,000 | $47,048,000 | 57,764,000 | $44,940,000 | 41,631,000 | $40,023,000 | 56,491,000 | $43,856,000 | 58,729,000 | $45,696,000 | 169,392,000 | $197,397,000 |
| 2042 | 48,793,000 | $47,321,000 | 58,019,000 | $45,180,000 | 41,848,000 | $40,257,000 | 56,744,000 | $44,093,000 | 58,993,000 | $45,937,000 | 170,469,000 | $198,635,000 |
| 2043 | 49,052,000 | $47,596,000 | 58,275,000 | $45,421,000 | 42,066,000 | $40,492,000 | 56,998,000 | $44,331,000 | 59,259,000 | $46,179,000 | 171,552,000 | $199,881,000 |
| 2044 | 49,312,000 | $47,872,000 | 58,532,000 | $45,663,000 | 42,286,000 | $40,728,000 | 57,254,000 | $44,570,000 | 59,526,000 | $46,422,000 | 172,642,000 | $201,135,000 |
| Revenue in 2014 Dollars. | | | | | | | | | | | | |
| 25Yr Avg Pct Change | 0.5% | 0.6% | 0.4% | 0.5% | 0.5% | 0.6% | 0.4% | 0.5% | 0.5% | 0.5% | 0.6% | 0.6% |
| 25Yr Avg 2020-2044 | 46,300,000 | $44,700,000 | 55,500,000 | $42,900,000 | 39,800,000 | $38,000,000 | 54,300,000 | $41,800,000 | 56,400,000 | $43,600,000 | 160,200,000 | $186,800,000 |

**Table ES-3** shows the 25-year annual trip and gross toll revenue stream for Alternative 7. Over 25 years, Alternative 7 is estimated to produce 3.0 million trips and $1.2 million (2014 dollars) and 2.7 million trips and $1.2 million (2014 dollars) in toll revenue annually for the I-91 and I-84 HOT lanes, respectively.

**Table ES-3**
**Estimated Annual Trips and Gross Toll Revenue**
**Alternative 7**

| | I-91 HOT Lanes | | | I-84 HOT Lanes | | |
|---|---|---|---|---|---|---|
| | Annual | Annual Gross Toll Revenue | | Annual | Annual Gross Toll Revenue | |
| Year | Toll Trips | Future Year $ | 2014 Dollars | Toll Trips | Future Year $ | 2014 Dollars |
| 2020 | 2,097,000 | $1,048,000 | $903,700 | 1,945,000 | $1,160,000 | $1,000,300 |
| 2021 | 2,155,000 | $1,095,000 | $921,200 | 1,997,000 | $1,206,000 | $1,014,600 |
| 2022 | 2,214,000 | $1,145,000 | $939,800 | 2,051,000 | $1,255,000 | $1,030,000 |
| 2023 | 2,275,000 | $1,197,000 | $958,500 | 2,106,000 | $1,305,000 | $1,045,000 |
| 2024 | 2,338,000 | $1,251,000 | $977,300 | 2,162,000 | $1,357,000 | $1,060,100 |
| 2025 | 2,403,000 | $1,308,000 | $996,900 | 2,220,000 | $1,411,000 | $1,075,400 |
| 2026 | 2,469,000 | $1,367,000 | $1,016,400 | 2,279,000 | $1,467,000 | $1,090,800 |
| 2027 | 2,537,000 | $1,429,000 | $1,036,600 | 2,341,000 | $1,526,000 | $1,107,000 |
| 2028 | 2,607,000 | $1,494,000 | $1,057,300 | 2,403,000 | $1,587,000 | $1,123,200 |
| 2029 | 2,679,000 | $1,561,000 | $1,077,800 | 2,468,000 | $1,651,000 | $1,140,000 |
| 2030 | 2,753,000 | $1,632,000 | $1,099,400 | 2,534,000 | $1,717,000 | $1,156,600 |
| 2031 | 2,829,000 | $1,706,000 | $1,121,200 | 2,602,000 | $1,785,000 | $1,173,100 |
| 2032 | 2,907,000 | $1,783,000 | $1,143,200 | 2,671,000 | $1,856,000 | $1,190,000 |
| 2033 | 2,988,000 | $1,864,000 | $1,166,000 | 2,743,000 | $1,931,000 | $1,207,900 |
| 2034 | 3,070,000 | $1,949,000 | $1,189,400 | 2,817,000 | $2,008,000 | $1,225,400 |
| 2035 | 3,155,000 | $2,037,000 | $1,212,800 | 2,892,000 | $2,088,000 | $1,243,200 |
| 2036 | 3,242,000 | $2,129,000 | $1,236,700 | 2,970,000 | $2,171,000 | $1,261,100 |
| 2037 | 3,331,000 | $2,226,000 | $1,261,500 | 3,049,000 | $2,258,000 | $1,279,600 |
| 2038 | 3,423,000 | $2,326,000 | $1,286,000 | 3,131,000 | $2,349,000 | $1,298,700 |
| 2039 | 3,518,000 | $2,432,000 | $1,311,800 | 3,215,000 | $2,442,000 | $1,317,200 |
| 2040 | 3,615,000 | $2,542,000 | $1,337,700 | 3,301,000 | $2,540,000 | $1,336,600 |
| 2041 | 3,715,000 | $2,657,000 | $1,364,100 | 3,389,000 | $2,642,000 | $1,356,400 |
| 2042 | 3,817,000 | $2,777,000 | $1,390,900 | 3,480,000 | $2,748,000 | $1,376,400 |
| 2043 | 3,922,000 | $2,903,000 | $1,418,600 | 3,573,000 | $2,858,000 | $1,396,600 |
| 2044 | 4,030,000 | $3,034,000 | $1,446,400 | 3,669,000 | $2,973,000 | $1,417,400 |
| Annual Pct Change | 2.8% | 4.5% | 2.0% | 2.7% | 4.0% | 1.5% |
| 25 year Annual Avg | 2,963,560 | $1,875,680 | $1,154,848 | 2,720,320 | $1,931,640 | $1,196,904 |

During the study, a conceptual look at the technical and operational aspects of the toll collection system to be implemented under AET of the I-84 corridor and of the I-91 and I-84 HOV lanes was conducted. In addition, preliminary tolling capital costs and tolling operations and maintenance costs were estimated for the seven tolling alternatives. Tolling operations and maintenance costs were estimated for both a Connecticut self-operated tolling operation and an outsourced tolling operation.

**Table ES-4** shows the average annual net toll revenue that could be expected for each tolling alternative. Tolling operations and maintenance costs, as well as tolling capital costs amortized over ten years are subtracted from the gross toll revenue estimates to produce the net annual toll revenue estimates. The last column shows the cumulative net toll revenue that could be produced over a 25-year period (2020 thru 2044). The net toll calculations were conducted for both the self and outsourced toll operations. For the I-84 Hartford based alternatives (1-5), cumulative net toll revenue over a 25-year period is estimated to range between $768 Million to $990 Million. Alternative 6 which includes expanded tolling between Hartford and New York is estimated to produce between $4.064 and $4.365 Billion in cumulative net toll revenue over a 25-year period. Alternative 7 is estimated to produce annual gross toll revenue that is higher than the annual tolling O&M costs. However, including the tolling capital cost amortized over a ten-year period in addition to the tolling O&M costs and subtracting from the gross toll revenue results in an overall negative net toll revenue for the HOT lanes.

**Table ES-4**
**Estimated Net Toll Revenue - 2014 Dollars**

**Self Operating Toll Operations and Maintenance**

| | 25 Year Annual Average (2020 thru 2044) | | | | 25 Year Total |
|---|---|---|---|---|---|
| Alternative | Gross Toll Revenue | O&M Cost | Cap Cost Amortized (1) | Net Toll Revenue (2) | Net Toll Revenue |
| 1 | $44,700,000 | $3,765,600 | $1,308,960 | $39,625,440 | $990,636,000 |
| 2 | $42,900,000 | $4,057,200 | $1,525,080 | $37,317,720 | $932,943,000 |
| 3 | $38,000,000 | $3,570,000 | $1,275,000 | $33,155,000 | $828,875,000 |
| 4 | $41,800,000 | $4,020,000 | $1,500,960 | $36,279,040 | $906,976,000 |
| 5 | $43,600,000 | $4,083,600 | $1,467,000 | $38,049,400 | $951,235,000 |
| 6 | $186,800,000 | $8,968,800 | $3,220,560 | $174,610,640 | $4,365,266,000 |
| 7 | $2,351,752 | $2,116,800 | $1,276,440 | -$1,041,488 | -$26,037,000 |

**Outsourced Toll Operations and Maintenance**

| | 25 Year Annual Average (2020 thru 2044) | | | | 25 Year Total |
|---|---|---|---|---|---|
| Alternative | Gross Toll Revenue | O&M Cost | Cap Cost Amortized (1) | Net Toll Revenue (2) | Net Toll Revenue |
| 1 | $44,700,000 | $6,770,400 | $1,308,960 | $36,620,640 | $915,516,000 |
| 2 | $42,900,000 | $7,878,000 | $1,525,080 | $33,496,920 | $837,423,000 |
| 3 | $38,000,000 | $5,995,200 | $1,275,000 | $30,729,800 | $768,245,000 |
| 4 | $41,800,000 | $7,724,400 | $1,500,960 | $32,574,640 | $814,366,000 |
| 5 | $43,600,000 | $7,975,200 | $1,467,000 | $34,157,800 | $853,945,000 |
| 6 | $186,800,000 | $21,002,400 | $3,220,560 | $162,577,040 | $4,064,426,000 |
| 7 | $2,351,752 | $1,885,200 | $1,276,440 | -$809,888 | -$20,247,000 |

Notes:
(1) Tolling capital cost spread over a 10 year period.
(2) Net toll revenue = gross toll revenue minus O&M and capital cost amortized.

## Conclusions

The primary objective of this study was to determine whether value pricing on I-84 through Hartford could provide congestion relief on one of the most heavily travelled and congested corridors in the State. Given the significant cost of replacing the I-84 Viaduct, toll revenue was also a key output of the analysis that needs to be considered across alternatives. The three primary performance metrics utilized across alternatives for this study were:

1. Congestion reduction (speed improvements) for I-84 drivers;
2. Local diversion and network impacts; and
3. Net toll revenue.

## I-84 Tolling Summary

On I-84 within Hartford, two tolling configurations were evaluated with the CRCOG travel demand model specifically refined for this analysis:

1. Single point toll located on the Viaduct segment of I-84; and
2. Two tolling locations, located west of the Sisson Avenue Interchange and east of the Asylum Interchange

While there were two build configurations evaluated in addition to the No Build alternative, the estimated traffic diversions attributed to tolling among these specific physical configurations did not vary significantly. The physical configuration of the alternatives contributed to larger variations in demand across the alternatives.

Because a large amount of the traffic on I-84 in Hartford has origins or destinations in the local area, coupled with a relatively dense network, a significant amount of toll avoidance would be possible (even at the relatively modest toll rate assumed). This is particularly evident with respect to a single point toll on the I-84 Viaduct in Hartford (Alternative 1 and 3). Traffic would be able to exit I-84 prior to the single point tolling location or enter I-84 beyond the single point tolling location to avoid the toll. For example, the ramps to and from the west at the Sisson Avenue interchange under Alternative 1 would be expected to increase significantly, as additional traffic would exit and enter I-84 at this location, rather than travelling through the tolling location to exit or enter at their preferred interchange. The other issue that was observed is that a significant uptick in volume on the ramps to and from the east at the Asylum interchange would occur to avoid passing through the tolling location. The existing demand at these ramps, particularly in the AM peak is already at levels that contribute to operational issues along I-84. In general, about a 30 percent reduction in traffic was estimated at the single point tolling location. From a regional diversion standpoint, only about 5 percent of the overall reduction in traffic at the tolling location can be attributed to longer distance regional diversion to avoid the toll.

The inclusion of two tolling locations within Hartford (Alternatives 2, 4, and 5) performs better than a single tolling point as the toll rate at each tolling location is half the toll of the single tolling point and thus results in lower diversion levels. The inclusion of two tolling locations also tends to disperse the diversion more widespread to the network rather than a single point toll. About a 24 percent reduction in traffic is estimated at each tolling location. The levels of diversion are still significant and were shown to be problematic to the local network if tolling locations are not carefully considered and potential mitigation strategies are not employed.

Alternative 6 which assumes a corridor approach to tolling was developed as the study evolved. It assumed 11 tolling locations along I-84 between Hartford and New York. Overall, about 82 percent of the traffic at the tolling locations is estimated to be retained under this alternative. The corridor approach to tolling has advantages of spreading out the cost of tolls, enables toll locations to be chosen that may be less conducive to diversion than a dense urban network environment, and can help generate significantly more revenue for costly investments throughout the corridor than a single tolling point.

Estimated net toll revenue over a 25-year period for Alternatives 1 through 5 ranged between $768 million and $991million. Alternative 6 is estimated to produce more than $4.0 Billion over a 25-year period. Revenue is in 2014 dollars.

## I-84 and I-91 HOT Lanes Summary

Analysis of a potential conversion of the existing I-84 and I-91 HOT lanes showed the potential for significant congestion benefits to both corridors as single occupant vehicles would now have the choice of using the existing HOV lanes for a fee. By reducing volumes in the general purpose lanes, travel speeds during the congested peak hours were shown to increase significantly. It should be noted that the western and southern termini of the I-84 and I-91 HOV lanes, respectively, if converted to HOT lanes would need further study to evaluate any physical changes needed to mitigate any operational issues which could be caused by more traffic exiting from the HOT lane into the general purpose lanes. Not addressing this potential issue could all but wipe out the benefits provided by the HOT lanes. Since the analysis and toll rate selection focused on "filling up" the HOT lanes to the maximum extent possible while preserving the free flow speeds of the HOT lane, the estimated annual net revenue is modest for each corridor. Estimated annual gross toll revenue would cover tolling operations and maintenance costs, but including the capital cost of tolling results in a net loss for the lanes. However, slightly higher toll rates could be implemented to off-set the cost if needed, with the objective of making it a revenue neutral or slightly positive stand-alone project.

## I-84 Microsimulation Summary

A microsimulation model of Hartford was developed to estimate the impacts of tolling in Hartford on the operations of both I-84 and the adjoining surface street roadways in Hartford. Based on the microsimulation modeling analysis completed for this project, significant insight was gained in terms of probable impacts of the Hartford tolling scenarios.

Of the two tested tolling scenarios (Alternative 1 and 2), Alternative 2 (two tolling locations) is the better candidate for further study with improved operations of the freeway. The westbound direction of I-84 in the AM peak period experiences significant congestion under current conditions extending back from the Asylum Street off-ramp. Under Alternative 2, large operational improvements are experienced with traffic now flowing near free flow conditions throughout the AM Peak Period. Other time periods and travel directions see moderate improvements in congestion as compared to the westbound AM period. Utilizing two tolling locations both minimizes and better distributes the local toll diversion traffic onto the surrounding arterial street system.

However, there are still several areas and intersections of the Hartford street network that may need additional capacity improvements to accommodate the toll traffic diversion to keep Hartford's roadways operating at acceptable levels of operations. For example, In Alternative 2, local drivers could avoid paying the toll at the first gantry location east of Asylum off ramp by exiting at the previous off-ramp to Main Street immediately upstream of the first toll gantry location. Drivers trying to get to downtown Hartford area would use the Main Street off-ramp to Chapel Street, and then would make a left turn at either Market Street, Main Street or Trumbull Street to reach the downtown area, while more westerly destined trips continue along Chapel Street and then seek to turn left at Pleasant Street or High Street. All these intersections have limited left turn capacity, and even with timing adjustments to increate left turn capacities, the signals are not able to accommodate the additional diversion traffic and eventually queues extend along Main Street and back onto the I-84 mainline. Immediately downstream of the Bulkeley Bridge, the four travel lanes of I-84 split to feed the off-ramp to I-91 Northbound and the Main Street off-ramp, with only two lanes continuing on I-84. These diverges are very closely spaced, and create additional weaving friction as vehicles position themselves in the correct lane. When the Main Street off-ramp queue eventually spills back to the I-84 Mainline, this weaving becomes increasing more difficult, and queues quickly build on I-84.

The arterials and intersections being impacted will ultimately depend on the configuration of the I-84 Viaduct replacement project as this alone could affect the patterns in and out of Hartford. If tolling is to be considered in the future, the local Hartford network would need further analysis once a final build alternative is selected by the I-84 Viaduct Study Team. Additional technical analysis should be conducted around the specific location of tolling points, the magnitude of toll rates during the peak and off peak time periods, toll discount policies, and revised tolling capital and operational cost estimates for a selected tolling system and operation should be developed. Similar refined analysis should be conducted for the I-91 and I-84 HOV to HOT projects if moved forward.